IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION

BALLY MANUFACTURING CORPORATION, Plaintiff, v. D. GOTTLIEB & CO., WILLIAMS ELECTRONICS, INC., ROCKWELL INTERNATIONAL CORPORATION, and GAME PLAN, INCORPORATED, Defendants.	)	CIVIL ACTION NO. 80 C 5048

MEMORANDUM OF PLAINTIFF IN OPPOSITION TO DEFENDANT ROCKWELL INTERNATIONAL CORPORATION'S MOTION TO DISMISS

Contents: Exhibits A through D

COP

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FOR THE NORTHERN DISTRICT OF ILLINOIS, EASTERN DIVISION

BALLY MANUFACTURING CORPORATION Plaintiff, vs. D. GOTTLIEB & CO., WILLIAMS ELECTRONICS, INC., AND ROCKWELL INTERNATIONAL CORPORATION, Defendants, and BALLY MANUFACTURING CORPORATION, Plaintiff, vs. GAME PLAN, INCORPORATED, AND ASTRO GAMES, INC., Defendants.	Civil Action No: 78C 2246 Civil Action No: 79C 713

DEPOSITION OF JOHN FOOTH

VOLUME VI

December 5, 1979

Reported by:

Shar Starkey-Nordstrom, CSR 2861

AMACK SHORTHAND REPORTING CORPORATION
Certified Shorthand Reporters
1519 East Chapman Avenue
Orange, California 92666
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CONTINUATION OF THE DEPOSITION OF JOHN FOOTH, taken by the Plaintiff, at 3370 East Miraloma Avenue, Anaheim, California, on Wednesday, December 5, 1979, commencing at 10:15 a.m., before Shar Starkey-Nordstrom, CSR #2861, a Notary Public, pursuant to subpoena.

APPEARANCES OF COUNSEL:

For Plaintiff: BALLY MANUFACTURING CORPORATION

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For Defendant: ROCKWELL INTERNATIONAL CORPORATION

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Houston, Texas 77056

E-X-H-I-B-I-T-S

PLAINTIFF'S EXHIBIT:	FOR IDENTIFICATION:
BD-81 - Subpoena	VI-3

Series of questions objected to pertaining to Document R-3295-M beginning on Page VI-17, Line 6.

Series of questions objected to beginning on Page VI-43, Line 11.

Pages 33 and 86 of Volume VI of the transcript of the deposition of John Footh have been designated by Rockwell as containing confidential information under a protective order entered by this Court in the 2246 case on October 15, 1979, and are therefore submitted to the Court in a separate envelope under seal.

IN THE UNITED STATES DISTRICT COURT

FOR THE NORTHERN DISTRICT OF ILLINOIS

EASTERN DIVISION

BALLY MANUFACTURING CORPORATION, Plaintiff, vs. D. GOTTLIEB & COMPANY, WILLIAMS ELECTRONICS, INC. and ROCKWELL INTERNATIONAL CORPORATION, Defendants.	CIVIL ACTION NO. 78 C 2246
and	
BALLY MANUFACTURING CORPORATION, Plaintiff, vs. GAME PLAN, INCORPORATED and ASTRO GAMES, INC., Defendants.	CIVIL ACTION NO. 79 C 713

DEPOSITION OF JOHN FOOTH
Volume VII
April 24,1980

Reported by:

Marvin T. Lusk, CSR #2284

AMACK SHORTHAND REPORTING CORPORATION
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DEPOSITION OF JOHN FOOTH taken by the Plaintiff at 3370 Miraloma Avenue, Anaheim, California, on Thursday, April 24, 1980, commencing at 10:10 a.m., before Marvin T. Lusk, CSR #2284, a Notary Public, pursuant to Notice.

APPEARANCES OF COUNSEL:

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Houston, Texas 77056

Pages 4 through 7 of Volume VII of the transcript of the deposition of John Footh have been designated by Rockwell as containing confidential information under a protective order entered by this Court in the 2246 case on October 15, 1979, and are therefore submitted to the Court in a separate envelope under seal.

A I don't recall.

Q Is Rockwell in production at the present time on the Gottlieb System II pinball controllers?

MR. ERICKSEN: Don't speculate.

THE WITNESS: Yes.

Q BY MR. KATZ: Are you aware of the production rate of such System II pinball controllers for Gottlieb?

MR. ERICKSEN: I'm going to object to that question. We've routinely excluded quantity and pricing information from discovery. That's been our position throughout.

MR. KATZ: I'm not asking. I'm asking if he's aware. Could you read my question back?

(Record read.)

MR. ERICKSEN: You may answer that question.

THE WITNESS: Yes.

Q BY MR. KATZ: What is that rate?

MR. ERICKSEN: Objection to the question and on relevancy grounds. We've routinely excluded pricing and quantity information, and I'll instruct you not to answer.

MR. KATZ: You've excluded it, but we have never agreed to that.

MR. ERICKSEN: Mr. Katz, documents you've given me, purportedly Bally documents, have had pricing and pricing information expunged, so don't tell me that you haven't agreed to it. You've done it yourself.

MR. KATZ: We're not talking about our information here, we're talking about your information.

MR. ERICKSEN: It makes a difference whether it's our

information or your information, right?

MR. KATZ: Yes.

MR. ERICKSEN: I don't think so.

MR. KATZ: I'd like to ask the witness for an answer to the question.

MR. ERICKSEN: I've instructed you not to answer it.

Q BY MR. KATZ: Do you accept your counsel's instruction?

A Yes.

Q Are you involved in any re-contacts with the Gottlieb people concerning the System II pinball controller?

A Yes.

Q And what are -- what is the general frequency of those contacts?

A It varies.

Q From what to what?

A Well, it depends. If somebody's got a question, or has a problem, then we have a conversation.

Q And what are the typical questions or problems which you have in mind?

A Oh, field reports.

Q Anything else?

A Improvements to the control system.

Q Anything else?

A Parts procurement.

Q Anything else?

A I don't recall.

Q Do you have any understanding or belief as to

why they communicate with you concerning these problems, as opposed to someone else?

A No.

Q Do you have any idea why?

MR. ERICKSEN: I'm going to object to that question on the grounds that it calls for this witness to testify about the thought processes of others, and if you undertake to answer the question, you should state in your answer the basis for such answer.

MR. KATZ: That's fine.

THE WITNESS: Well, I'm the engineer on this side of the program, and we generally discuss potential problems to the configuration or the production of it. Basically, I'm always consulted by the program manager in these matters.

Q BY MR. KATZ: Is that Mr. Gross?

A Yes.

Q What are the field reports that you mentioned?

A Just basic discussions of how the machines are performing out in the field.

Q Do they ever report to you anything in respect to competitor's machines from the field?

A I don't recall.

(Discussion held off record between Mr. Katz and Mr. Schnayer.)

Q BY MR. KATZ: Mr. Footh, I ask you to take a look in your notebook, the third book which was -- runs through the period of December 6, '76, through May 31, '77, I believe, and please turn to page 4 in that book.

before?

A Yes.

Q And what do you recognize this to be?

A This I.L. is a response to a higher level of corporate, assessing the risk of follow-on business.

Q What do you mean by risk of follow-on business?

A I don't know the details. It's in that directive.

Q I just mean what did you mean by the terms of follow-on business?

A Well, I suppose it means whether it's going to be profitable.

Q Are you familiar with the -- strike that.

This document says, "John Footh, the responsible designer since the beginning of the Gottlieb program remains the full-time responsible engineer through the follow-on program."

Did that in fact occur? Did you remain the full-time responsible engineer through the follow-on program?

A Yes.

Q This document says, "36,000 sets of Gottlieb pinball printed circuit modules have been delivered through July, 1978, at a rate of 5,000 sets per month." It goes to to say, "A set consists of a control board, a master driver board, a four digit display board and four, six digit display boards."

Do you know whether that's an accurate statement of fact as of August, 1978?

A No.

Q Do you have any belief that would be inconsistent with that statement?

A No.

Q Did this follow-on proposal -- strike that.

Does this follow-on program continue beyond the August, 1978, date that this document bears?

A Yes.

Q For how long?

A I don't recall.

Q Did it continue into 1979?

A I don't recall.

Q Do you know if it's still continuing today?

A No.

Q It's not continuing -- were you the responsible designer throughout the entire follow-on program?

A Yes.

Q Do you have any idea as to when that program terminated?

MR. ERICKSEN: I think the question has been asked and answered. How many times are you going to ask it? The witness has testified he didn't recall.

THE WITNESS: I don't recall. Our business is done by contract, and I don't know when the contract begins and ends.

Q BY MR. KATZ: I understand you don't recall the specific date when it ends?

A That's right.

Q But do you have any idea as to when it would have

ended or did end?

A No.

Q Was this follow-on program superceded or succeeded by another follow-on program with respect to the Gottlieb pinball controller?

MR. ERICKSEN: Objection to the question as leading. Also vague as to what is meant by the Gottlieb pinball program.

THE WITNESS: Do you want me to answer.

MR. ERICKSEN: If you can.

THE WITNESS: Yes.

Q BY MR. KATZ: And how did that program differ from this program

MR. ERICKSEN: What program is "that program"?

Q. BY MR. KATZ: The program, the succeeding program, how did that follow-on program differ from the follow-on program that was the subject of this document, R3530M?

A I don't have any way of knowing.

Q But it also dealt with Gottlieb pinball controllers?

A Yes.

Q And is there currently some follow-on program of Rockwell dealing with Gottlieb pinball controllers?

A Yes.

Q And are you the responsible engineer on that follow-on program, the one that's currently in existence?

A Yes.

AMUSEMENT GAME MICROPROCESSOR CONTROLLER

ABSTRACT

A microcomputer based pinball game controller having three distinct memory devices for control of game operation. A first memory device utilizes machine language programming instructions for control of the game independent of specific game rules thus lending itself to mass production for a large number of different amusement games. A second memory device employs a higher level language set of instructions for controlling the game in accordance with the specific rules of the game. A simple set of higher level language instructions renders this second memory device conducive to game designer programming and easy modification of the game rules, a marketing procedure traditionally used in the design of the electromechanical pin ball machine. A third memory device, employing a matrix of operator adjustable binary switches easily accessible to the exterior of the game, permits a degree of game mode control, such as the degree of playing difficulty and the number of games for a given coin denomination.

FIELD OF THE INVENTION

This invention relates generally to a microprocessor controlled pinball game, and more specifically to a game rule memory device in combination with a pinball game controller for simplified and low cost game rule programming.

BACKGROUND OF THE INVENTION

A revolution has been taking place in a design of equipment which until now has been implemented with electromechanical devices. The logic and control functions previously performed by conventional relays, time delay relays, stepping relays, timing motors and the like are now being performed by microcomputer controlled systems. Included in this revolution are the fairly complex electromechanical devices known as pinball games.

Most of us have played electromechanical controlled pinball games, but few of us have appreciated the complexity of design that controls the flashing lights, the score, the sound and the entire pinball system. This degree of control system complexity is very suitable to microprocessor applications. In fact, microprocessor control significantly reduces the amount of material and the cost of complex pinball games at the same time increasing reliability and uptime thereby increasing the potential revenue of the arcade owner.

However there is an important problem inherent in the design, production, and subsequent use by parties having substantially different levels of sophistication in electronics-related systems that have traditionally been purely electromechanical in nature. The current invention substantially overcomes this problem providing in effect three different levels of sophistication in the programming of the parameters of a pinball game. The microprocessor electronics and associated interface usually manufactured by an electronics/microprocessor-oriented company includes the most sophisticated programming and design for overall control of the game. Standard memory devices such as read-only memory and random access memory may, by means of the invention described herein, be programmed for a large number of different games, each of which has different rules of operation.

The manufacturer of the pinball game per se, although perhaps less sophisticated in design of electronics having been traditionally associated with purely electromechanical devices, is still the ultimate expert on rules of the game to optimize player interest and revenue derived from the public. Accordingly, the current invention provides means for rule programming at a substantially higher language level by the pinball game manufacturer. The extent of the sophistication of the programming requirements is well below that required for the en masse programming of the ROM and RAM memory devices provided by the

electronics manufacturer, but still provides substantial leeway in allowing the game manufacturer to select a set of rules that suits each particular game.

The current invention also provides a set of discrete operator adjustments which comprise a relatively low level of programming sophistication, but which still permit the arcade owner to program certain aspects of the game which may vary as a function of where the pinball game is located. For example, these functions include the price of play, the number of games per coin, and the degree of difficulty of the game, which depends upon the sophistication of the player. Clearly, an arcade location would usually dictate a higher level of difficulty than a bus terminal location where the average level of player sophistication is lower.

An important byproduct of the current invention is a substantial reduction in the cost of overall manufacture and maintenance of the pinball game. The electronics manufacturer need not provide special electronics for each variation of game rules supplied by the pinball game manufacturer. As a result, all of the microprocessor electronics may be identical, irrespective of the type of game into which it will be installed. Consequently, the game manufacturer, in addition to paying less for the electronics, also reduces his cost for maintenance of the games by needing fewer spare parts for upkeep because virtually all of the electronics are identical for all of his games irrespective of variations in rules and modes of play.

SUMMARY OF THE INVENTION

The present invention is a microprocessor controlled pinball game having means for three levels of control program sophistication including overall game action control in response to mass produced and commonly programmed memory storage devices, a higher level language

game rule memory device which permits relatively simple variations in the electronics to accommodate each set of game rules, and a third level of control in the form of binary switch memory accessible to the ultimate consumer for convenient control of simple mode game parameters.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an isometric drawing of a typical pinball game.

Figure 2 is a block diagram of the microcomputer based pinball controller of the invention.

Figure 3 is a diagrammatic illustration of the instruction formats used in conjunction with the game rule memory device of the invention.

Figure 4 is an illustration used to explain the logical equivalencies of a game rule memory device of the invention.

Figure 5 is an illustration of examples of electromechanical logic.

DESCRIPTION OF A PREFERRED EMBODIMENT

Before proceeding to a description of the microcomputer implemented pinball machine, a brief description of the electromechanical version of the pinball game is provided in conjunction with Figure 1.

Electromechanical pinball games may be divided into three major subsystems: the vertical display 12, play field 14, and the credit subsystems. The vertical display 14 shows the player and ball status and each of the player's scores. The electromechanical design for the display is essentially the same for all pinball games except for the art work which ties the system to the scheme of each particular game.

The playing field contains the contact and lights which define the play of the game and electromechanical assemblies for kicking the ball to provide action in the game.

The credit subsystem, accepts information from the mechanical coin mechanism 16a and 16b and displays credits for playing games based upon the price per play and the coin values accepted. The credit system also accepts inputs from the play field logic to award credits for additional games based on achieving specific goals established by the game designer and settings made by the operator of the game. These game credits are stored in a reversible stepping relay which decrements the credit count as credits are spent to play additional games. The credit information is displayed on the vertical display 14.

The basic electromechanical building blocks consist of a number of standard elements which are interconnected to provide a proper score when a play field contact, such as roll over switch 18, closes. The contact closure also provides signals to solenoid-operated chimes or bells to latch relays, control lights, and enable circuit paths through contacts which allow varying scores depending on play field action as well as on bonus scores for extra games. The entire system is synchronized by means of a multicam contact timing motor so that no race conditions will occur. A race condition occurs when uncertainty in relay operation time causes unpredictable circuit paths to be established because different relays may "win the race" to closure in different situations.

The typical electromechanically controlled pinball game contains about 70 coils, of which 20 to 25 are stepping relays, 35 are logic related, and 10 to 15 are used for mechanical lockouts, ball movement or chime solenoids. In one embodiment of a microcomputer controlled pinball game, all of the above-mentioned coils, except those used for chime solenoids, are replaced by the microcomputer.

The typical electromechanical pinball game is developed and produced over an extended period of time. The game designer usually

spends several months defining the location of the play field contacts, any special play field action items, such as solenoid operated bumpers, the scoring for each contact, and any optional scoring sequences under which the bonus system operated. The game designer strives to develop a game which is interesting, having a considerable amount of action, plays for an acceptable period of time, and which has the capability of awarding the typical player approximately 30 to 35 percent free games. These parameters have been empirically established over the approximately 40 year history of pinball games to insure game interest and coin revenue to the machine owners.

Once the game is shipped, the microcomputer-based game must still have a level of programmability by the game/owner operator to achieve the desired play time, player acceptability, free game characteristics and adjustable price as the electromechanical version. The microcomputer based pinball game must give the game designer the same level of design creativity available to him in the traditional electromechanical version. The game designer must still be able to implement variations in the scoring, in the contact logic, and in the general play of the game. Furthermore, changes in these parameters by the game designer must be possible as a result of the method by which pinball games are usually marketed.

Approximately two months before a pinball game is scheduled to go into production, 200 to 300 units are typically put into the field in a test marketing situation. The machines are placed with knowledgable distributors who maintain detailed records relating to the action of players, the income gathered from the coin collection box, and other pertinent information relating to the general acceptance of the pinball game. This information is fed to the manufacturer so that the game designer can make minor modifications to the game before putting it into production. By means of the current invention, a microcomputer version of the pinball game

permits fast design development, because of the ease of making the changes of the game rule parameters simply by programming a read-only memory device. As a result, unlike the electromechanical versions, in the computer-based games changes in the play of the game can be implemented even as the machine is being readied for shipment.

Referring now to Figure 2, there is shown therein a simplified block diagram of a game controller of the current invention for use in a microcomputer based pinball game. The controller includes a central processing unit 20, a general purpose keyboard display circuit 22, two memory/input-output devices 24 and 26, and one general purpose input-output device 28. These devices provide all of the control capabilities, a total of 4,000 eight bit words of program memory, 1,000 bits of data memory, and 85 input-output lines. The total system is capable of displaying up to 32 decimal digits for scoring purposes and the like and can switch up to 68 discrete power devices such as lamps and coils.

The general purpose keyboard display circuit device 22 provides internal memory for the 32 binary coded decimal digits, and outputs the information in sequential pairs along with digital identification lines. Sequential binary coded decimal codes are supplied to a pair of binary coded decimal-to-7 segment decoded driver units 30 and 32. This configuration of the controller allows CPU 20 to load the internal memory once and then the general purpose keyboard display circuit 22 provides continuous refresh of the display information until it is commanded to change. The display system and the associated digital displays replace the scoring drums of the electromechanical systems. The scoring drums are basically stepping relays typically with several sets of contacts, with a drum around the outer periphery which rotates and shows a different digit for each position of the stepping relay.

The central processor 20 employs a TV crystal base clock oscillator (not shown) and 12 input-output lines. The input-output lines are

used to address the game rule memory device 34. RAM/ROM devices 24 and 26 each have 2,048 eight bits of read-only memory which contains the main controller program. They each also have 128 four-bit words of random access memory for the player scores, status bit memory, play field contact memory and other alterable memory. These devices also have 16 input-output lines each.

The general purpose input-output circuit 22 has a total of 24 input-output lines. The general purpose keyboard display circuit is used to buffer, refresh and control the 32 decimal digits of display. The digit strobe signals are multiplexed in two banks of eight digits. The CMOS random access memory 36 is a device which keeps data available even when power is lost or turned off, and is powered by a battery system 38 to keep the memory active. The operator adjustable matrix 40 is an array of diodes which may be independently switched in or out of the circuit so that operator selection of preprogrammed game options may be made. Operator adjustable matrix 40 shares strobe lines with 8 of the 5 amp coil drivers. These coil drivers may be shared because the matrix information may be read in a few microseconds which is too short for the solenoids or relay armatures to react. The 8x8 contact matrix 42 is scanned by signals from one of the RAM/ROM devices and return signals are read into the general internal memory to prevent bouncing error and appropriate action is initialized. Because up to 16 coil drives and up to 52 lamp drives are required in a pinball game, the output signals from the 15 four bit latches 44 go to two types of drivers: 5 amps and 250 milliamps respectively.

The play field system, which is visible to the eye of the player, is virtually unchanged in the microcomputer version of the pinball game. The mechanical devices which propel the ball are still necessary for exciting field action. Scoring contacts are closed to provide signals to the microcomputer rather than to operate conventional relays and stepping

relays found in the electromechanical games. Indicator lights showing the play field scoring status are implemented in the microcomputer game by drivers which receive a control signal from conventional TTL latches. The microcomputer selects the information to be sent to the latch and outputs it while at the same time identifying which latch is to receive the information. The contact closure information is obtained in the microcomputer system by providing a sequence of scanning signals which selects sequential groups of contacts. The microcomputer inputs the information from each group and performs the debounce function.

Because of implementation with a microcomputer, the pinball game can be provided with a capability which is not achievable in the electromechanical version. The microcomputer can be put into a special mode when the coin collector comes to collect the coins. This mode tests the overall operation and identifies by means of the display system, the contact identification information for every contact which is stuck. During this test mode the microcomputer can also output various display patterns to check the display system. It can also drive the lights to check operation of all the light bulbs and can individually drive all the solenoids of the play field and coin system to check their operation. In addition, the microcomputer can provide various bookkeeping and status information to the coin collector not possible with the electromechanical system. In the microcomputer system the bookkeeping information is stored in low power dissipation CMOS memory 36 which maintains its information even when system power is off, by means of small battery system 38.

The central processing unit 20 of Figure 2, may by way of example be a Rockwell model PPS 4/2 CPU which is described in more detail in data sheet Document No. 29000D02 published by Rockwell International Corporation in 1975 and Revised March 1976.

The ROM/RAM devices 24 and 26 of Figure 2 may by way of example be a Rockwell Model A17XX described in more detail in data sheet Document

No. 29000028 published by Rockwell International Corporation in 1975 and Revised in October 1976.

The GP10 (General Purpose Input/Output Device) 28 of Figure 2 may by way of example be a Rockwell Model GP10 chip described in more detail in data sheet Document No. 29000006 published by Rockwell International in 1975.

The GPKD (General Purpose Keyboard and Display Circuit) 22 of Figure 2 may by way of example be a Rockwell GPKD circuit chip described in more detail in data sheet Document No. 10788N40 published by Rockwell International in 1975.

The PROM utilized for storing the higher level language program may by way of example be a programmable read only memory Model 6351 manufactured by Monolythic Memories Incorporated.

The requirement for stepping relays for bonus advancing or for timing motors to eliminate race conditions is eliminated from the microcomputer system. The position of a stepping relay can be implemented in the microcomputer by storing a number in memory representing the stepper position. The microcomputer can use this number as part of a program logic sequence to implement the desired function for that position. The microcomputer can provide sequence information much more readily and because of the sequential operation of the microcomputer, the timing motor is not required since race conditions are impossible.

The software approach used in the implementation of the microcomputer pinball game of the current invention is actually implemented in three levels: the first programming level includes those basic control functions that every pinball game controller is expected to perform. These are the necessary power on, sequencing and control, display operation, player and ball counting operations, play field input computations, general play field control operations for functions such as "tilt" and functions which occur when the ball leaves the playing field, and similar operations

which do not change from game to game. This program is generated by the controller designer to allow the system to be a general pinball game controller, and is the program stored in the microcomputer fixed read-only memory contained in the RAM/ROM devices 24 and 26.

The next level of programming is generated by the game designer and is accomplished in an interpretative program format. This means that the game controller program in the RAM/ROM devices interprets programs written in a higher level language oriented toward pinball game rules. Using this higher level language, the game designer selects the operation response to each contact in easy to use sentence descriptions of the rules of the game. The instructions used in this higher level pinball-game oriented language (PGOL) are indicated in Table I and the instruction format for two types of instructions are presented in Figure 3.

As indicated in Figure 3 there are basically two types of instruction format. Format A is used for copying or setting the logic state on certain lights, flags, or solenoids as the game proceeds. Instruction format B is used to control the score of the game. As indicated in Figure 3, each instruction format includes an OP code comprising four bits. This OP code identifies the instruction generated. The Format A instruction also includes a true-false bit which indicates whether the flag, light, or solenoid, the state of which is being copied or set, should be copied or set in its current state or in an inverted state. A light-flag bit indicates whether the instruction will have an effect on a light or on a flag or solenoid. The right-most eight bits of the Format A instruction include a light or flag address word of six bits and a light or flag subaddress comprising two bits. In combination these eight bits designate the specific light, flag or solenoid the instruction operates on.

The Format B instruction, which is specifically oriented to effecting scoring changes, includes an add-subtract bit which indicates whether an addition or subtraction should be made to a score. It also includes a

TABLE I

PGOL INSTRUCTION SET

MNEMONIC	OP CODE	ADDRESS		FUNCTION
*COPY	0	TLBB	CCCC	COPY LAMP/FLAG STATE TO CONTROL BIT
*SCORE	1	ANNN	VVVV	ADD/SUBTRACT TO/FROM SCORE
*SET	2	TLBB	CCCC	SET/RESET LAMP/FLAG/SOL
*CGOTO	3	QQQQ	RRRR	CONDITIONAL GO TO LOCATION/QQQQ RRRR
RFLG	4	-	-	ROTATE FLAGS (11-20) LEFT ONE POSITION
*RBUP	5	-	-	BONUS UP
*RBDN	6	-	-	BONUS DOWN
*REQL	7	MMMM	-	IF REG ≠ MMMM, CONTROL BIT = 0.
*DECR	8	-	-	DECREMENT INDEX REGISTER
*INCR	9	-	-	INCREMENT INDEX REGISTER
OR	A	TLBB	CCCC	OR LAMP/FLAG STATE WITH CONTROL BIT
FLAG	B	-	-	SET CONTROL BIT = 1
STOP	C	-	-	RETURN TO MAIN PROGRAM
TOGL	D	-	-	TOGGLE CONTROL BIT
GOTO	F	QQQQ	RRRR	GO TO LOCATION QQQQ RRRR
DELAY	F	-	-	150 MILLISECONDS DELAY

*ONLY EXECUTED IF THE CONTROL BIT = 1

column number comprising three bits which indicate which column of the score display is being affected by the current instruction. Finally, the instruction contains four bits indicating the number of operations to effect the score change. For example, if 5,000 is to be added to the score, the add bit would be TRUE, the column number would correspond to five, so that one would be added five times to the thousands column of the score.

When a contact on the play field closes in response to the play of the game, the controller program stored in the RAM/ROM devices causes the instructions in a particular section of the higher level language memory to be executed. The sequence of instructions starting at a particular program location corresponding to the contact closure, indicates exactly what the game is to do when the contact closes. For example, one contact may simply cause the system to score 100 points for the player who is operating the game. In this case, the higher level language program consists of two instructions: 1) score 100 points and 2) stop. The stop code indicates the completion of the operation related to this particular contact closure. If another contact is closed, the controller may cause the instruction sequence for that contact to be executed; for example, the contact instructions may be as follows: when contact 1 closes, if contact 3 and contact 11 have been closed, score 1,000, otherwise score 100 and stop. This requires six higher level language instructions to implement. In both of these examples, the controller program interprets what the game designer defined by the higher level language instructions and executes a sequence of machine language instructions to accomplish each instruction and to continue to the next one.

The philosophy of operation of the higher level language program is that a controlled flag bit in a microcomputer memory is initially set to a ONE state. A higher level language instruction inspects the state

of that bit and performs the operation specified if the bit continues to be in the ONE state. Many of the logic type higher level language instructions control the state of the bit to cause blocks of logic to be ignored or executed as the situation demands. The unconditional instructions control the flow of the logic and always execute regardless of the state of the control bit or flag bit. The higher level language is a general logic language with some special instructions which relate to pinball operations. Special pinball instructions are the "score" instructions, the "increment-decrement bonus" instructions, the "increment-decrement" register instruction and the "register equal" instructions.

From the instructions listed in Table I, it can be seen that the full capability for sequential logic is provided by AND functions and OR functions with TRUE or FALSE states. Figure 4 illustrates the equivalent high level language statement for the four basic logic operations. These four basic logic operations are shown in relay circuit, logic gate symbols, and higher level language statement forms. In the logic gate illustrations, the input lines on the left are active when the line is shaded. If the gate passes a signal, the output is shaded. The shaded inputs are then equivalent to the relay being activated in the relay logic, or to the bit memory being in the ON state in the higher level language equivalent.

The higher level language program provides a capability for counting events and making decisions based upon the actual value of the count. Also provided is the capability for inserting time delays and for setting, resetting, and testing individual status bits in a bit memory in the microprocessor system to store the status of contact closures, light bulb drives, coil drives and logic information.

Using the higher level language program, the game designer can easily and quickly configure the logical options for a particular game and modify them as he develops information about the general play of the game and its level of difficulty. In one embodiment of the invention,

this higher level language program is implemented in programmable read-only memory PROM, even in the production system, so that the game modifications which must be made from feedback from the field operations can be implemented right up to the last moment in the production line.

A general example for implementing a block of mechanical logic with the higher level language programming of the current invention is illustrated in Figure 5. The higher level language program statements corresponding to the electromechanical logic of Figure 5 would be as indicated below:

If register equals 5, set bit D, always.

If register equals 4, set bit E, always.

If register equals 3, and if bit C is on, set bit F, always.

If register equals 2, and if bit A is off, and if bit B is on, and if bit C is off, set bit G always.

Or if register equals 2,and if bit A is on, and bit B is off, and bit C is off, set bit G always.

If register equals 1, and if bit A is off and if bit B is on and if bit C is on, set bit H always.

If register equals 0, and if bit A is on, set bit K.

STOP

Table II is a program listing of a programmable read only memory unit used in a preferred embodiment of the invention to store the higher level language used for game rule control. The column on the left is the input address to the PROM, expressed in hexadecimal format. The next four columns, labeled W1, W2, W3 and W4 respectively, are the hexadecimal representations of the output of the PROM generated in response to the input address. The next column to the right is an instruction number used for reference in the listing. The next column to the right is a label used to identify each step in the listing for GoTo operations. The next column to the right is the name of the OP code for each instruction in

TABLE II

```
PBA 04/10/76
ADDR W1 W2 W3 W4     ISN.  LABEL   OP     OPERAND

                       1   *          PGOL PROGRAM LISTING - GAME #409
                       2   *  FLAGS   F11-F20 KICKOUT HOLE-SPOT ROLLOVER INDICATORS
                       3   *          F1  ALL ROLLOVERS DOWN
                       4   *          F2  ALL DROP TARGETS DOWN
                       5   *          F3  ALL DROP TARGETS DOWN  1ST PASS ONLY
                       6   *          F4  SPECIAL AWARD
                       7   *          L4  SAME PLAYER SHOOTS AGAIN
                       8   *          F5  SPECIAL HIT
                       9   *          F6  EXTRA BALL HIT
                      10   *          F8  SBALL=0 BBALL=1
                      11   *          F7  TEMP FLAG -(10 POINTS)
                      12   *          F9  TEMP FLAG
                      13   *          F21 EXTRA BALL
                      14   *
0100 E 4 1 5          15              GOTO  INIT
0104 E 2 6 B          16              GOTO  BONUS
0108 F F F F          17              FILL  24
0120 E 3 C B          18   S10P       GOTO  10P          10 POINT
0124 E 3 C 0          19   SCPB       GOTO  CPB          CENTER POP  BUMPER
0128 E 3 A 3          20   SRTG       GOTO  RTG          RIGHT TARGET
012C E 2 F D          21   SCTG       GOTO  CTG          CENTER TARGET
0130 E 3 B 6          22   SLTG       GOTO  LTG          LEFT TARGET
0134 F F F F          23              FILL  12
0140 E 1 C 0          24   SBRO       GOTO  BR01         BLUE ROLLOVER
0144 E 1 D 1          25   SGRO       GOTO  GR01         GREEN ROLLOVER
0148 1 A 5            26   SRRB       SCORE A1000,5      RIGHT ROLLOVER BUTTON
014B C                27              STOP
014C E 2 0 C          28   SWDT       GOTO  WDT          WHITE  DROP TARGET
0150 E 2 0 2          29   SYDT       GOTO  YDT          YELLOW DROP TARGET
0154 F F F F          30              FILL  12
0168 E 2 2 A          31   SGDT       GOTO  GDT          GREEN  DROP TARGET
016A E 1 B 2          32   SRRO       GOTO  RR01         RED ROLLOVER
016B E 2 1 6          33   SRDT       GOTO  RDT          RED    DROP TARGET
016C E 1 9 C          34   SYRO       GOTO  YR01         YELLOW ROLLOVER
0170 E 1 A 1          35   SWRO       GOTO  WR01         WHITE ROLLOVER
0174 F F F F          36              FILL  12
0190 E 3 7 E          37   SRPB       GOTO  RPP          RIGHT POP BUMPERS
0194 E 3 1 2          38   SRHL       GOTO  RHL          RIGHT HOLE
0198 E 3 0 4          39   SLHL       GOTO  LHL          LEFT  HOLE
019C E 2 2 0          40   SBDT       GOTO  BDT          BLUE  DROP TARGET
                      41   *
                      42   *    YELLOW ROLLOVER
```

TABLE II (CONTINUED)

```
PSA 04/10/76
ADDR W1 W2 W3 W4   ISN  LABEL   OP     OPERAND

0190  0  C  7        43  YR01    COPY   TL28
0193  2  4  7        44          SET    FL28
0196  2  6  6        45          SET    FL22
0199  2  C  2        46          SET    TL8
019C  9              47          INCR
019D  E  1  D  E     48          GOTO   ROV
                     49  *
                     50  *   WHITE ROLLOVER
                     51  *
01A1  0  D  8        52  WR01    COPY   TL29
01A4  2  5  8        53          SET    FL29
01A7  2  7  6        54          SET    FL23
01AA  2  E  2        55          SET    TL6
01AD  9              56          INCR
01AE  E  1  D  E     57          GOTO   ROV
                     58  *
                     59  *   RED ROLLOVER
                     60  *
01B2  0  E  8        61  RR01    COPY   TL30
01B5  2  6  8        62          SET    FL30
01B8  2  D  2        63          SET    TL5
01BB  9              64          INCR
01BC  E  1  D  E     65          GOTO   ROV
                     66  *
                     67  *   BLUE ROLLOVER
                     68  *
01C0  0  F  8        69  BR01    COPY   TL31
01C3  2  7  8        70          SET    FL31
01C6  2  4  6        71          SET    FL24
01C9  2  F  2        72          SET    TL7
01CC  9              73          INCR
01CD  E  1  D  E     74          GOTO   ROV
                     75  *
                     76  *   GREEN ROLLOVER
                     77  *
01D1  0  C  8        78  GR01    COPY   TL32
01D4  2  4  8        79          SET    FL32
01D7  2  5  7        80          SET    FL25
01DA  2  D  3        81          SET    TL9
01DD  9              82          INCR
                     83  *
                     84  *   ROLLOVER
```

TABLE II (CONTINUED)

```
PBA 06/10/76
ADDR W1 W2 W3 W4    ISN   LABEL   OP     OPERAND
                     85   *
                     86   ROV     COPY   TL5          IF ALL ROLLOVERS DOWN
01DE  0  D  2        87             COPY   TL6
01E1  0  E  2        88             COPY   TL7
01E4  0  F  2        89             COPY   TL8
01E7  0  C  2        90             COPY   TL9
01EA  0  D  3        91             SET    TF1          F1=1
01ED  2  0  0        92             SET    TF3           1ST PASS FLAG
01F0  2  B  0        93             FLAG
01F3  B              94             COPY   FF8
01F4  0  0  1        95             SCORE  A100,5
01F7  1  B  5        96             FLAG
01FA  B              97             SET    FF8
01FB  2  0  1        98             GOTO   RODT
01FE  E  3  D  2     99   *
                    100   *   YELLOW  DROP TARGET
                    101   *
                    102   YDT     COPY   FL13         NEED 'COPY' FOR 1ST PASS FLAG
0202  0  5  4       103            SET    TL13
0205  2  D  4       104            GOTO   DT
0208  E  2  3  0    105   *
                    106   *   WHITE DROP TARGET
020C  0  7  3       107   WDT      COPY   FL11
020F  2  F  3       108            SET    TL11
0212  E  2  3  0    109            GOTO   DT
                    110   *
                    111   *   RED DROP TARGET
0216  0  6  3       112   RDT      COPY   FL10
0219  2  E  3       113            SET    TL10
021C  E  2  3  0    114            GOTO   DT
                    115   *
                    116   *   BLUE DROP TARGET
0220  0  4  3       117   BDT      COPY   FL12
0223  2  C  3       118            SET    TL12
0226  E  2  3  0    119            GOTO   DT
                    120   *
                    121   *   GREEN DROP TARGET
0229  0  4  4       122   GDT      COPY   FL14
022D  2  E  4       123            SET    TL14
                    124   *
                    125   *   DROP TARGETS - EXTRA BALL AND SPECIAL LIGHTS
                    126   *
```

TABLE II (CONTINUED)

```
PUA 06/10/76
ADDR W1 W2 W3 W4    ISN  LABEL   OP     OPERAND

0230  0  E  3        127  DT      COPY   TL10
0233  0  F  3        128          COPY   TL11
0236  0  C  3        129          COPY   TL12
0239  C  D  4        130          COPY   TL13
023C  0  E  4        131          COPY   TL14
023F  2  A  0        132          SET    TF2
0242  2  B  0        133          SET    TF3
0245  2  C  7        134          SET    TL26      CENTER TARGET
                     135  *
                     136  *   DROP TARGETS - SCORE
                     137  *
0248  B              138          FLAG
0249  7  1           139          REQL   1
024B  1  A  1        140          SCORE  A1000,1
024E  B              141          FLAG
024F  7  2           142          REQL   2
0251  1  A  2        143          SCORE  A1000,2
0254  B              144          FLAG
0255  7  3           145          REQL   3
0257  1  A  3        146          SCORE  A1000,3
025A  B              147          FLAG
025B  7  4           148          REQL   4
025D  1  A  4        149          SCORE  A1000,4
0260  B              150          FLAG
0261  7  5           151          REQL   5
0263  1  A  5        152          SCORE  A1000,5
0266  B              153          FLAG
0267  E  3  D  2     154          GOTO   RODT
                     155  *
                     156  *   BONUS COUNTDOWN
                     157  *
                     158  *   GREEN BONUS
                     159  *
026B  2  F  5        160  BONUS   SET    TL19
026E  0  D  3        161          COPY   TL9
0271  0  E  4        162          COPY   TL14
0274  1  A  1        163          SCORE  A1000,1
0277  F  F           164          FILL   2
0279  0  C  5        165          COPY   TL20
027C  0  D  6        166          COPY   TL21
027F  1  A  1        167          SCORE  A1000,1
0282  F  F           168          FILL   2
```

TABLE II (CONTINUED)

```
PBA 06/10/76
ADDR W1 W2 W3 W4    ISN   LABEL   OP    OPERAND
0284  B             169           FLAG
0285  2  7  5       170           SET   FL19
                    171   *
                    172   *  YELLOW BONUS
                    173   *
                    174           SET   TL18        YELLOW
0288  2  E  5       175           COPY  TL8
0289  0  C  2       176           COPY  TL13
028E  0  D  4       177           SCORE A1000,2
0291  1  A  2       178           FILL  2
0294  F  F           179           COPY  TL20
0294  0  C  5       180           COPY  TL21
0299  0  D  6       181           SCORE A1000,2
029C  1  A  2       182           FILL  2
029F  F  F           183           FLAG
02A1  B             184           SET   FL18
02A2  2  6  5       185   *
                    186   *       BLUE  BONUS
                    187           SET   TL17
02A5  2  D  5       188           COPY  TL7
02AB  0  F  2       189           COPY  TL12
02AB  0  C  3       190           SCORE A1000,3
02AE  1  A  3       191           FILL  2
02B1  F  F           192           COPY  TL20
02B3  0  C  5       193           COPY  TL21
02B6  0  D  6       194           SCORE A1000,3
02B9  1  A  3       195           FILL  2
02BC  F  F           196           FLAG
02BE  B             197           SET   FL17
02BF  2  5  5       198   *
                    199   *  WHITE BONUS
02C2  2  C  4       200           SET   TL16
02C5  0  E  2       201           COPY  TL6
02C8  0  F  3       202           COPY  TL11
02C9  1  A  4       203           SCORE A1000,4
02CC  F  E           204           FILL  2
02D0  0  C  5       205           COPY  TL20
02D3  0  D  6       206           COPY  TL21
02D6  1  A  4       207           SCORE A1000,4
02D9  F  F           208           FILL  2
02DB  B             209           FLAG
02DC  2  4  4       210           SET   FL16
```

TABLE II (CONTINUED)

```
PBA 06/10/76
ADDR W1 W2 W3 W4     ISN   LABEL   OP      OPERAND
                     211   *
                     212   *   RED BONUS
                     213           SET     TL15
02DF  2  F  4        214           COPY    TL5
02E2  0  D  2        215           COPY    TL10
02E5  0  E  3        216           SCORE   A1000,5
02E8  1  A  5        217           FILL    2
02EB  F  F           218           COPY    TL20
02ED  0  C  5        219           COPY    TL21
02F0  0  D  6        220           SCORE   A1000,5
02F3  1  A  5        221           FILL    2
02F6  F  F           222           FLAG
02F8  B              223           SET     FL15
02F9  2  7  4        224           STOP
02FC  C              225   *
                     226   *   CENTER TARGET
                     227   *
02FD  0  6  7        228   CTG     COPY    FL26        CENTER TARGET=1 ?
0300  1  B  5        229           SCORE   A100,5
0303  D              230           TOGL
0304  1  A  5        231           SCORE   A1000,5
0307  C              232           STOP
                     233   *
                     234   *   LEFT HOLE
                     235   *
0308  2  C  5        236   LHL     SET     TL20        LEFT HALF DOUBLE BONUS=1
030B  2  2  5        237           SET     FF22
030E  E  3  1  8     238           GOTO    HOLE
                     239   *
                     240   *
                     241   *   RIGHT HOLE
0312  2  D  6        242   RHL     SET     TL21        RIGHT HALF DOUBLE BONUS=1
0315  2  A  5        243           SET     FF22
0318  0  A  9        244   HOLE    COPY    TF30        3 BALL ?
031B  1  A  5        245           SCORE   A1000,5     SCORE 5000
031E  D              246           TOGL                OTHERWISE
031F  1  A  3        247           SCORE   A1000,3     SCORE 3000
0322  B              248           FLAG
0323  0  A  5        249           COPY    TF22
0326  2  A  D        250           SET     TS6
0329  D              251           TOGL
032A  2  B  D        252           SET     TS7
```

TABLE II (CONTINUED)

```
PSA 06/10/76
ADDR W1 W2 W3 W4    ISN   LABEL   OP     OPERAND
0320  B             253           FLAG
0322  2  A  8        254           SET    TF34
0325  2  B  1        255           SET    TF8
0328  2  8  2        256           COPY   TF12
032A  0  8  2        257           COPY   TF38      3BALL
032D  0  A  9        258           OR     TF11
032F  A  B  2        259           GOTO   YR01      SPOT YELLOW ROLLOVER
0332  E  1  9  0     260           FLAG
0334  B             261           COPY   TF14
0335  0  A  3        262           COPY   TF38
0338  0  A  9        263           OR     TF13
033B  A  9  3        264           GOTO   WR01      SPOT WHITE ROLLOVER
033D  E  1  A  1     265           FLAG
0340  B             266           COPY   TF16
0341  0  8  3        267           COPY   TF38
0344  0  A  9        268           OR     TF15
0347  A  8  3        269           GOTO   RR01      SPOT RED ROLLOVER
034A  E  1  8  2     270           FLAG
034C  B             271           COPY   TF18
034D  0  A  4        272           COPY   TF38
0350  0  A  9        273           OR     TF17
0353  A  9  4        274           GOTO   BR01      SPOT BLUE ROLLOVER
0356  E  1  C  0     275           FLAG
0358  B             276           COPY   TF20
0359  0  8  4        277           COPY   TF38
035C  0  A  9        278           OR     TF19
035F  A  8  4        279           GOTO   GR01      SPOT GREEN ROLLOVER
0362  E  1  D  1     280           FLAG
0364  B             281           SET    FF8
0365  2  0  1        282           STOP
0367  C             283   *
                     284   *   LEFT OR RIGHT POP BUMPERS
                     285   *
0368  1  B  1        286   POP     SCORE A100*1
036A  4               287           LBDN              MOVE ROLLOVER FLAG ONE POSITION
                     288   *
                     289   *   EXTRA BALL LITES (L41-L40)
                     290   *
036B  E  4  5  9     291           GOTO  POP01
                     292   *
                     293   *   LEFT TARGET
                     294   *
```

TABLE II (CONTINUED)

```
PBA 06/10/76
ADDR W1 W2 W3 W4    ISN   LABEL   OP     OPERAND
0386  1  B  5        295  LTG     SCORE  A100,5
0389  0  F  9        296           COPY   TL35        SPECIAL ?
038C  2  7  9        297           SET    FL35        L35=0
038F  2  9  1        298           SET    TF5         DISABLE SPECIAL
0392  2  8  0        299           SET    TF4         CREDIT FLAG
0395  B             300           FLAG
0396  0  E  9        301           COPY   TL34        EXTRA BALL=1 ?
0399  2  6  9        302           SET    FL34        L34=0
039C  2  A  1        303           SET    TF6         DISABLE EXTRA BALL
039F  2  9  5        304           SET    TF21         EXTRA BALL FLAG
03A2  C              305           STOP
                     306  *
                     307  *   RIGHT TARGET
                     308  *
03A3  1  B  5        309  RTG     SCORE  A100,5
03A6  0  C  9        310           COPY   TL36        SPECIAL ?
03A9  2  4  9        311           SET    FL36        L36=0
03AC  2  9  1        312           SET    TF5
03AF  2  8  0        313           SET    TF4         CREDIT FLAG
03B2  B              314           FLAG
03B3  0  D  9        315           COPY   TL33        EXTRA BALL ?
03B6  2  5  9        316           SET    FL33        L40=0
03B9  2  A  1        317           SET    TF6
03BC  2  9  5        318           SET    TF21         EXTRA BALL FLAG
03BF  C              319           STOP
                     320  *
                     321  *   CENTER POP BUMPER
                     322  *
03C0  0  A  9        323  CPB     COPY   TF30        3 BALL ?
03C3  1  A  1        324           SCORE  A1000,1     SCORE 1000
03C6  D              325           TOGL               OTHERWISE
03C7  1  8  1        326           SCORE  A100,1      SCORE 100
03CA  C              327           STOP
                     328  *
                     329  *   10 POINTS
                     330  *
03CB  1  C  1        331  10P     SCORE  A10,1
03CE  2  6  8        332           SET    TF36        ALTERNATE SPECIAL AND EXTRA BALL LIGHTS
03D1  C              333           STOP
                     334  *
                     335  *   ROLLOVER AND DROP TARGET EXIT ROUTINE
03D2  0  B  0        336  RODT    COPY   TF3         1ST PASS ?
```

TABLE II (CONTINUED)

```
PBA 04/10/76
AUDR W1 W2 W3 W4     ISN   LABEL   OP     OPERAND
0305  0  6  9        337           COPY   FL34
0308  0  5  9        338           COPY   FL33      ((L33,L34)=0 ?
030B  0  2  1        339           COPY   FF6       EXTRA BALL NOT HIT ?
030E  0  7  9        340           COPY   FL35
0311  0  4  1        341           COPY   FL4
0314  2  E  9        342           SET    TL34
0317  B               343           FLAG
031A  0  B  0        344           COPY   TF3       1ST PASS ?
031D  0  9  0        345           COPY   TF1       ALL ROLLOVERS ?
0320  0  A  0        346           COPY   TF2       ALL DROP TARGETS ?
0323  0  6  9        347           COPY   FL34      L34=0 ?
0326  0  1  1        348           COPY   FF5
0329  2  F  9        349           SET    TL35      L35=1  (SPECIAL)
032C  B               350           FLAG
032D  0  B  0        351           COPY   TF3       1ST PASS ?
0330  0  9  0        352           COPY   TF1       ALL ROLLOVERS ?
0333  0  A  0        353           COPY   TF2       ALL DROP TARGETS ?
0336  0  5  9        354           COPY   FL33      L33=0 ?
0339  0  7  9        355           COPY   FL35
033C  0  1  1        356           COPY   FF5
033F  2  C  9        357           SET    TL36      L36=1  (SPECIAL)
0342  B               358           FLAG
0343  2  3  0        359           SET    FF3
0346  C               360           STOP
                      361  *
                      362  *   INITIALIZATION
                      363  *
0347  2  C  7        364  INIT    SET    TL28
034A  2  D  8        365           SET    TL29
034D  2  E  8        366           SET    TL30
0350  2  F  8        367           SET    TL31
0353  2  C  8        368           SET    TL32
0356  2  E  6        369           SET    TL22
0359  2  F  6        370           SET    TL23
035C  2  C  6        371           SET    TL24
035F  2  D  7        372           SET    TL25
0362  2  B  2        373           SET    TF11
0365  2  8  D        374           SET    TS8
0368  2  B  D        375           SET    TS9
036B  2  8  D        376           SET    TS0
036E  0  2  6        377           COPY   TF27
0371  9  9  6        378           COPY   TF25      LAST BALL ?
```

TABLE II (CONTINUED)

```
PBA 06/10/76
ADDR W1 W2 W3 W4   ISN  LABEL   OP     OPERAND
0442  2  C  5      378          SET    TL20
0445  2  D  6      380          SET    TL21          DOUBLE BONUS=1
0448  B           381          FLAG
0449  0  A  6      382          COPY   TF26
044C  0  9  6      383          COPY   TF25          LAST BALL ?
044F  0  A  9      384          COPY   TF38          3 BALL ?
0452  2  C  5      385          SET    TL20
0455  2  D  6      386          SET    TL21          DOUBLE BONUS=1
0458  C           387          STOP
                   388  *
                   389  *   ALTERNATE EXTRA BALL LITE WITH 5 BALL
                   390  *
0459  0  9  0      391  POP01   COPY   TF1           ALL B.O.'S
045C  A  A  0      392          OR     TF2           OR CT.HS
045F  E  4  6  4   393          GOTO   POP1
0463  C           394          STOP
0464  0  2  1      395  POP1    COPY   FF6           EXTRA BALL HIT ?
0467  E  4  6  C   396          GOTO   POP2          NO
046A  C           397          STOP                 YES
046C  0  2  9      398  POP2    COPY   FF38          3 BALL ?
046F  E  4  7  4   399          GOTO   POP3          NO
0473  C           400          STOP
0474  0  D  9      401  POP3    COPY   TL33          L33=1?
0477  E  4  A  7   402          GOTO   POP4          YES
047B  B           403          FLAG
047C  0  E  9      404          COPY   TL34          L34=1 ?
047F  E  4  A  9   405          GOTO   POP5          YES
0483  B           406          FLAG
0484  0  C  9      407          COPY   TL36          L36=1 ?
0487  E  4  B  0   408          GOTO   POP6
048B  B           409          FLAG
048C  0  F  9      410          COPY   TL35          L35=1 ?
048F  E  4  B  4   411          GOTO   POP7
0493  B           412          FLAG
0494  0  B  5      413          COPY   TF23
0497  2  D  9      414          SET    TL33
049A  B           415          FLAG
049B  0  3  5      416          COPY   FF23
049E  2  E  9      417          SET    TL34
04A1  C           418          STOP
04A2  2  5  9      419  POP4    SET    FL33          L33=0
04A5  2  B  5      420          SET    TF23          F23=1
```

TABLE II (CONTINUED)

```
PUA 06/10/76
ADDR W1 W2 W3 W4    ISN   LABEL   OP    OPERAND
04A8  C             421           STOP
04A9  2  6  9       422   POP5    SET   FL34        L34=0
04AC  2  3  5       423           SET   FF23        F23=0
04AF  C             424           STOP
04B0  2  E  9       425   POP6    SET   TL34        L34=1
04B3  C             426           STOP
04B4  2  D  9       427   POP7    SET   TL33
04B7  C             428           STOP
                ***  429
0
```

the listing. The next column to the right is a name given to the OPERAND of the instruction indicating what the instruction will act on. The final column to the right is a brief explanation of the instruction in the listing.

By way of an example in using the program listing of Table II, instruction number 50 is labeled White Rollover. This label corresponds to a series of higher level language instructions which occurs in response to a contact closure when a Rollover switch, such as switch 18 of Figure 1, is activated by the pinball. As indicated at instruction number 52, the input address to the higher level language PROM is 01A1 in hexadecimal form and the output is 0D8 in hexadecimal form. The label given to this instruction and to the five instructions that follow and that together comprise this subroutine designated White Rollover is WR01. The first step is a copy instruction which calls for copying TRUE light 29. The next step, with input address 01A4, output 258, is a set instruction to set FALSE light 29. After two more set instructions, the subroutine calls for an increment of an index register in the PROM by means of input address 01AD and output 9. The final instruction in this subroutine White Rollover, is a GoTo instruction where the address of the destination of the GoTo instruction is ROV which as shown as instruction number 86 is the name of another subroutine clled Rollover.

An example of a Score instruction is shown at instruction number 26 of Table II. The input address of the PROM is 0148, and the output is 1A5 which as indicated by the OPCODE and OPERAND, is an instruction which causes an increase in the score by 5,000 which is accomplished by adding to the 1,000th column a total of five times.

SUMMARY

It will now be understood that what is described herein is a microcomputer based pinball machine controller having a means for three different levels of programming and control. The first level is a machine language program that may be provided in mass production quantities by the controller designer and is capable of accomodating all of the anticipated variations for which the controller may be used irrespective of the particular rules of a pinball game. The second level is a higher level language interpretive routine having a high level language flexible instruction set permitting pinball game designers to utilize their creativity in the design of the rules of the game without requiring large amounts of programming time ordinarily needed to establish the rules of a particular game. The third level, the least sophisticated in terms of an actual knowledge of the detailed electronics of the controller, permits operator control by means of binary switches of general game mode operations, such as the difficulty of play and the number of plays for each coin.

Although a specific embodiment has been described it will be understood that the invention is not limited to the particular implementation utilized and that the invention could be implemented in other forms of logic including other types of hardware and software to accomplish the operations described herein. However, all such alternative embodiments are contemplated within the scope of the invention.

The invention has been described in more than sufficient detail to enable one skilled in the art to make and use the invention. For purposes of brevity and to avoid inadvertent obfuscation of the important elements of the invention, certain trivial aspects have not been described in specific detail. By way of example, specific time relationships of clock signals have not been specifically delineated. However, these

aspects of the invention will now be readily apparent to those having skill in the applicable art and having the teaching of the applicants before them.

The invention described herein may be employed in many ways different from that specifically set forth and many variations may be made therein within the scope of the appended claims.

I claim:

1. In a microprocessor control amusement game having lamps, coils, and display, a game controller comprising:

a central processing unit,

a contact matrix providing input signals to said processing unit in response to player operated game operation,

a machine language memory device connected to said central processing unit for storing pre-programmed instructions for control of game operation independent of the specific rules of the game,

a game rule memory device connected to a central processing unit for storing program instructions for control of game operation dependent upon the specific rules of the game,

output signal driver means connected to said central processing unit for applying signals to said lamps, coils, and display in response to said input signals, said machine language memory device instructions, and said game rules memory device instructions.

2. A game controller as defined in Claim 1, further comprising:

an operator adjustable matrix memory device connected to said machine memory device and programmed for mode control of said game.

3. A microprocessor amusement game controller comprising:

first programmed means for controlling game operation independent of the specific rules of play,

second program means for controlling game operation dependent upon the specific rules of play, and

third program means for controlling the mode of game operations.

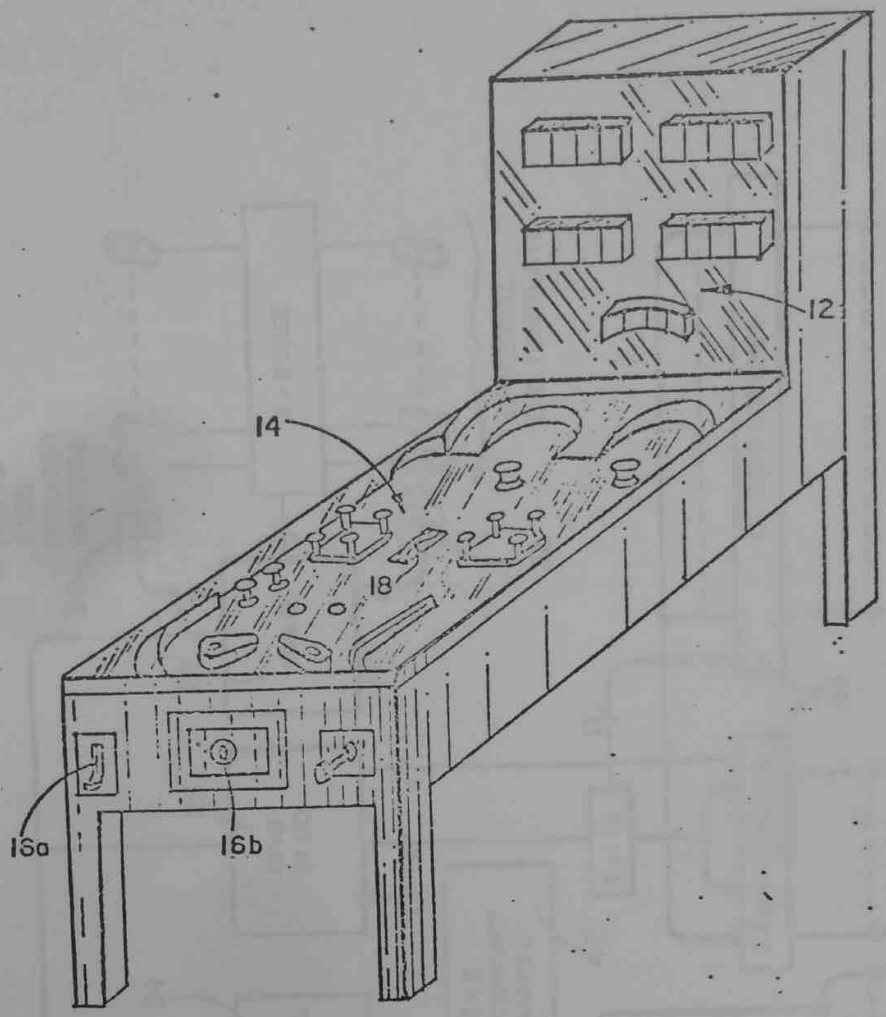


FIG. 1

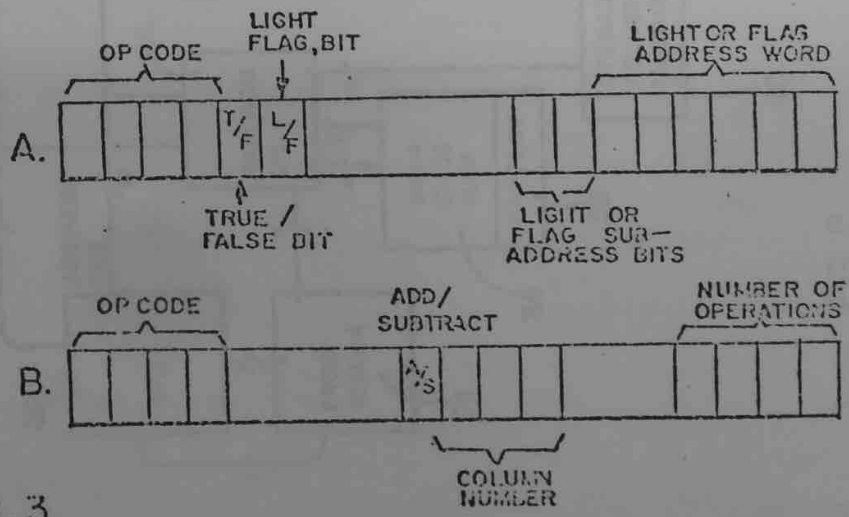


FIG. 3

R8500.30

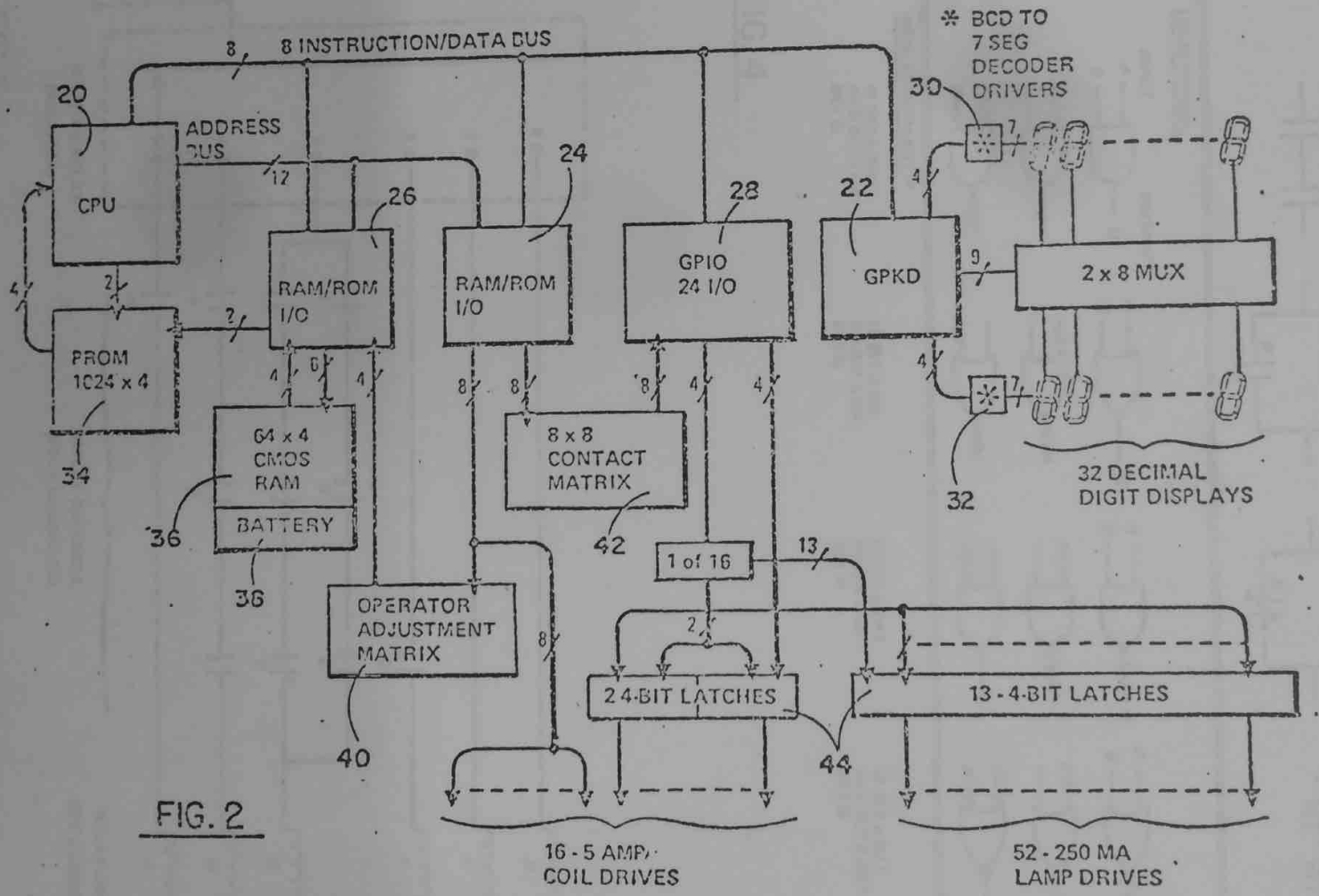


FIG. 2

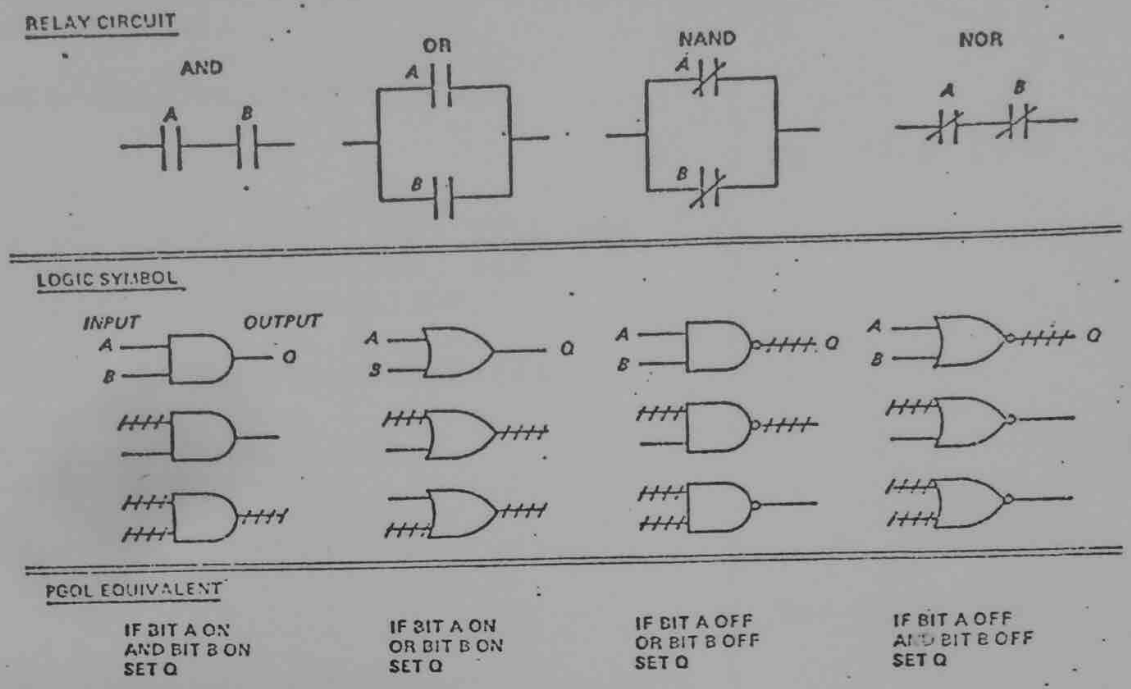


FIG. 4

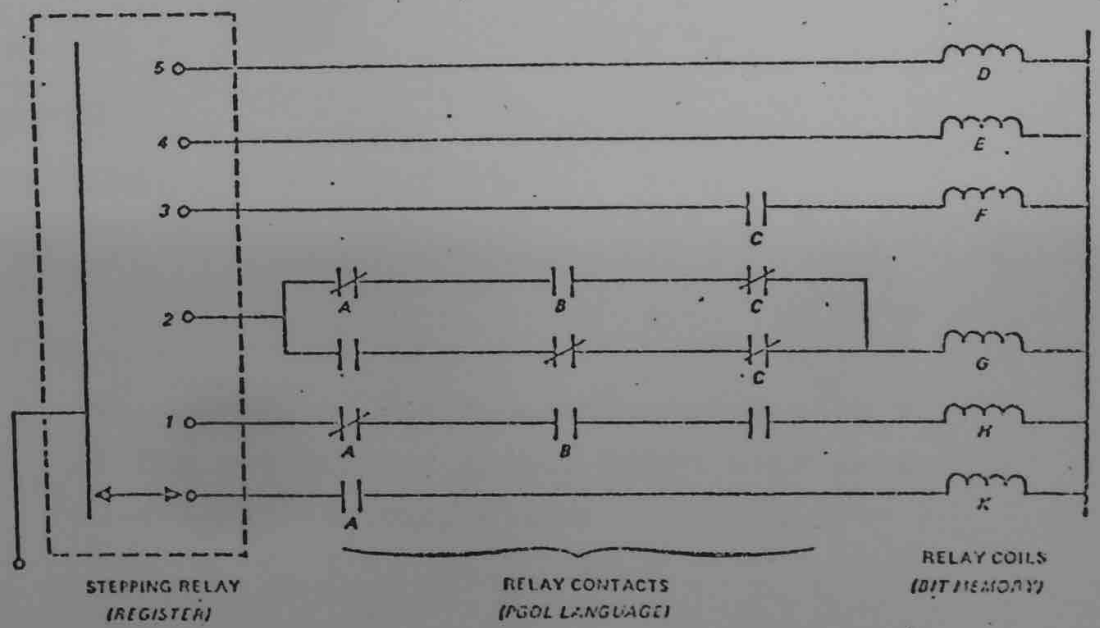


FIG. 5

R8500.32

IN THE UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION

BALLY MANUFACTURING CORPORATION, a Delaware corporation, Plaintiff/Counterdefendant, vs. D. GOTTLIEB & CO., a corporation, WILLIAMS ELECTRONICS, INC., a corporation, and ROCKWELL INTERNATIONAL CORPORATION, Defendants/Counterplaintiffs,	No. 78 C 2246
BALLY MANUFACTURING CORPORATION, a Delaware corporation, Plaintiff, vs. GAME PLAN, INCORPORATED, a Delaware corporation, Defendant.	No. 79 C 713

Tuesday, January 15, 1980
10:15 a.m.

PRESENT:
MR. WELSH
MR. KATZ
MR. SCHNAYER

MR. GOLDENBERG

MR. LYNCH
MR. HARDING

MR. MEYERS

(The taking of the deposition of MARION F. BRACHA was resumed at 135 South LaSalle Street, Room 1540, Chicago, Illinois, as follows:)

Q Well, do you recall a patent application filed at any time in which you were named with Mr. Englehardt as a co-inventor pertaining to pinball games?

A Yes.

Q You do not know when that was?

A I don't recall.

Q I show you a document and represent to you and Mr. Welsh that it is a copy, a certified copy, of a patent application, serial number 633,470 filed in the United States Patent Office, Patent and Trademark Office, on November 19, 1975.

I ask you, sir, in looking at that document, does that refresh your recollection on when the patent application was filed with you and Mr. Englehardt as co-inventors pertaining to microcomputer control of pinball games?

MR. WELSH: Are you going to mark this as an exhibit?

MR. GOLDENBERG: I would be delighted to do that. I do not know what my next exhibit is.

MR. SCHNAYER: Can I examine that, please?

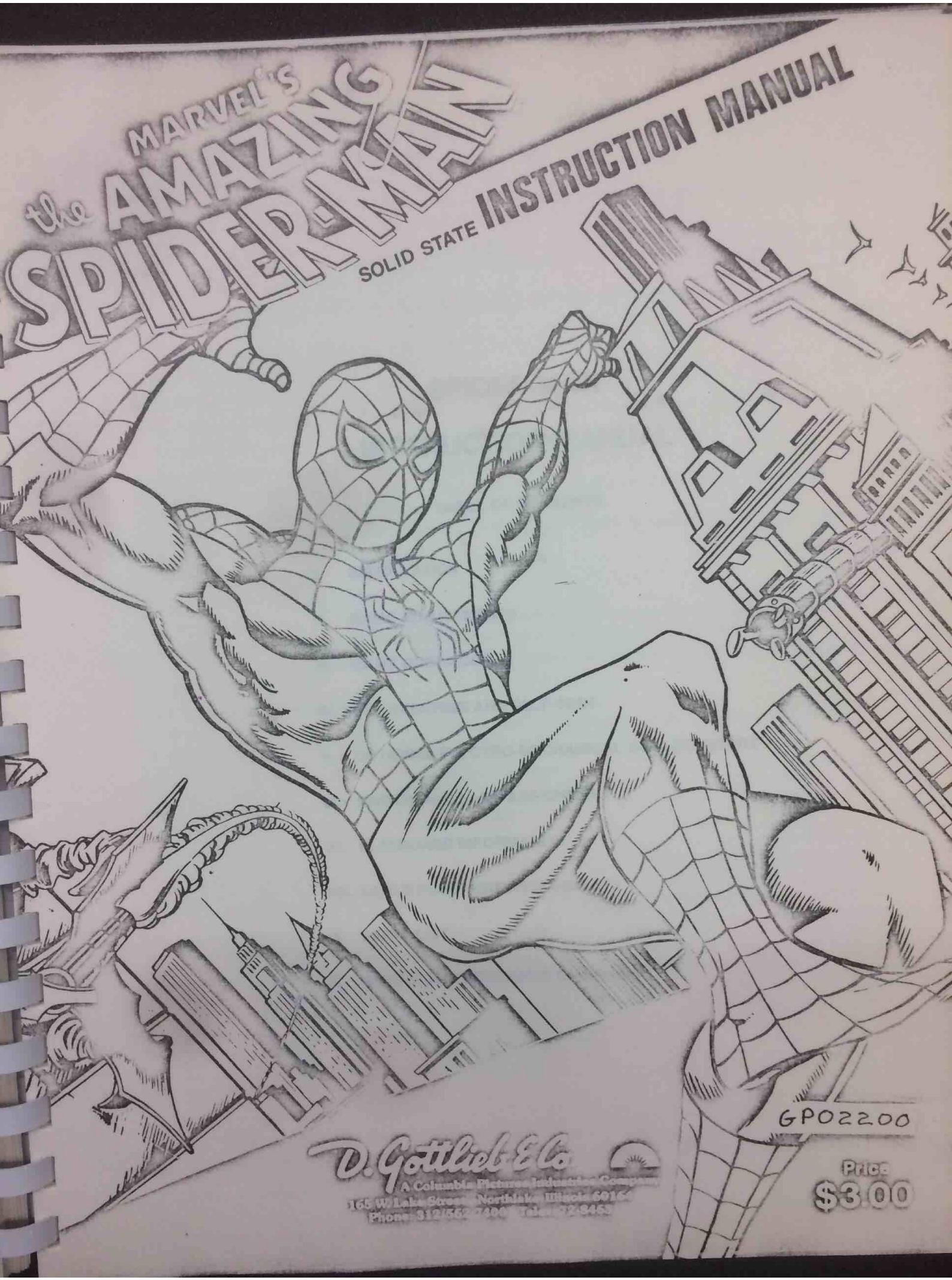
MR. GOLDENBERG: Well, you can see it later.

MR. SCHNAYER: I just want to take a quick look through it.

MARVEL'S

the AMAZING SPIDER-MAN

SOLID STATE **INSTRUCTION MANUAL**



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SPIDER-MAN

INSTRUCTION MANUAL

TABLE OF CONTENTS

I. INSTALLATION

To assemble the game, first bolt the legs to the cabinet. Feed the line cord through the slot provided in the pedestal. Place the lightbox atop the pedestal and engage the holding brackets.

To remove glass, insert key and unlock. Lift glass up and swing bottom out. Loosen and lower the shipping bracket at top center of lightbox insert panel. Lift panel up and then swing out. Secure lightbox to cabinet with the four bolts and washers provided.

Connect all cables and secure with cable clamps provided. Inspect the following **before** plugging in line cord:

1. Check that cables are clear of moving parts.
2. Look for any disconnected wires.
3. Check switches for loose solder or other foreign matter.
4. Be certain all fuses are firmly seated.
5. Check the transformers for foreign matter across the terminals.
6. Be sure that the transformer wiring corresponds to the supply voltage.
7. Check the setting of the tilt switch on the underside of the playfield. One blade of this switch is free-floating with a weight on the end.

   After levelling the machine, adjust the plumb-bob tilt (on left side of cabinet near front door) to the sensitivity desired.

II. GAME ADJUSTMENTS

A. PLAYFIELD ADJUSTMENTS

The game is shipped with adjustable posts in the position found to be suitable for the greatest number of players. Therefore the posts should not be changed unless the need is clearly evident.

The "conservative" (easier entry) position decreases playing time and scoring while the "liberal" position has the opposite effect.

B. LIGHTBOX ADJUSTMENTS

There are 32 switches on the control board which permit adjustment of the game parameters. These switches are contained in four packages of eight switches each, as shown below:

S1 – S8	S9 – S16	S17 – S24	S25 – S32

SWITCHES — **COIN CHUTE ADJUSTMENTS**

S1	S2	S3	S4	Left Chute
S5	S6	S7	S8	Right Chute
S9	S10	S11	S12	Center Chute

NOTE: FOR GERMAN GAMES ONLY, switches S5-S8 adjust the center chute and switches S9-S12 adjust the right chute.

				COINS/CREDITS
OFF	OFF	OFF	OFF	1/1
OFF	OFF	OFF	ON	1/2
OFF	OFF	ON	OFF	1/3
OFF	OFF	ON	ON	1/4
OFF	ON	OFF	OFF	1/5
OFF	ON	OFF	ON	1/6
OFF	ON	ON	OFF	1/7
OFF	ON	ON	ON	1/8
ON	OFF	OFF	OFF	1/9
ON	OFF	OFF	ON	2/1*
ON	OFF	ON	OFF	2/2*
ON	OFF	ON	ON	2/3*
ON	ON	OFF	OFF	2/4*
ON	ON	OFF	ON	2/5*
ON	ON	ON	OFF	1/1 and 2/3
ON	ON	ON	ON	3/1*

*NO CREDITS UNTIL LAST COIN IS INSERTED

SWITCH 13 — **EXTRA CREDITS**

ON ..... Adds 9 credits to center coin chute setting
OFF ..... No effect

NOTE: FOR GERMAN GAMES ONLY. Switch 13 adds 9 credits to the **right** coin chute setting, when ON.

SWITCH 14 — **COIN CHUTE CONTROL**

ON ..... Left and Right Chutes Same
OFF ..... Left and Right Chutes Separate

NOTE: FOR GERMAN GAMES ONLY. Switch 14 controls the **left** and **center** coin chutes.

SWITCHES 15 16 — **MAXIMUM CREDITS**

15	16	
OFF	OFF	8
OFF	ON	10
ON	OFF	15
ON	ON	25

SWITCH 17 — **BALLS PER GAME**

ON 3
OFF 5

SWITCH 18 — **MATCH FEATURE**

ON ..... ON
OFF ..... OFF

SWITCH 19 — **REPLAY LIMIT**

ON ..... Limits each player to one replay per game
OFF ..... No replay limit

SWITCH 20 — **NOVELTY MODE**

ON ..... Playfield SPECIAL and EXTRA BALL features award 50,000 points and 5 knocks. High score, high game to date, and match features disabled.
OFF ..... Normal game mode.

NOTE: SWITCH 20 overrides SWITCH 21

SWITCH 21 — **GAME MODE**

ON ..... Extra Ball
OFF ..... Replay

NOTE: IF SWITCH 21 is ON, the high game to date and match awards are disabled.

SWITCH 22 — **PLAYFIELD SPECIAL**

ON ..... Awards Extra Ball
OFF ..... Awards Special

SWITCHES 23 24 — **HIGH GAME TO DATE**

23	24	
OFF	OFF	Not displayed — no award
OFF	ON	Displayed — No award
ON	OFF	Displayed — awards 2 replays
ON	ON	Displayed — awards 3 replays

SWITCH 25 — **SOUND WHEN SCORING?**

ON ..... Yes
OFF ..... No

SWITCH 26 — **REPLAY BUTTON TUNE?**

ON ..... Yes
OFF ..... No

SWITCH 27 — **COIN SWITCH TUNE?**

ON ..... Yes
OFF ..... No

SWITCH 28 — **CREDITS DISPLAYED?**

ON ..... Yes
OFF ..... No

SWITCH 29 — **TILT PENALTY**

ON ..... Ball in play only
OFF ..... Game over

SWITCH 30 — **ATTRACT FEATURES**

ON ..... ON
OFF ..... OFF

SWITCHES 31, 32 — Liberal/Conservative

(Not used on Game #653)

C. ELECTRONIC SOUND ADJUSTMENTS

There are two switches on the SOUND BOARD which allow variation:

SWITCH S1

OFF ..... SOUND MODE
ON ..... TONE MODE

SWITCH S2

OFF ..... NO ATTRACT TUNE
ON ..... ATTRACT TUNE PLAYED EVERY 6 MINUTES

The volume control is on the bottom panel in the cabinet and is accessible from the front door opening.

III. GAME OPERATION

With the line cord unplugged drop a coin into one of the chutes. It should be rejected. Plug the line cord ONLY into a properly grounded 3-wire receptacle of the correct voltage. Turn on the game by pressing the main switch located on the cabinet bottom near the front right corner.

After a five second delay the relays will pulse and the score displays will light and show all zeros. The credit display will show the number of credits remaining and the ball in play display will be blank. If the credits fail to light, turn off the game and inspect the ball roll assembly switch and the front door slam switch. They are both normally closed.

Five seconds after the score displays light, they will flash the High Game to Date score for one second. This cycle continues until the game is started. A number of playfield lights controlled by the MPU will be flashed to create an attract mode.

Insert coins into each chute and note that the correct number of credits are added on the credit display according to the information on the coin entrance plate. Press the replay button to reset the game; the ball should now be at the shooter. The first player score reads zero and flashes, indicating that that player is now scoring. The other player displays are blank and a one appears on the ball in play display. Additional players are indicated by a zero showing in each corresponding player display. After the maximum number of players has been added, or when the credit display reads zero, the replay button has no effect.

When the ball enters the outhole the bonus is scored, the ball is kicked to the shooter, and the display of the player now scoring begins to flash and continues to flash until a score is made. When the Shoot Again light is lit neither the player designation (flashing display) nor the ball in play display changes when the ball enters the outhole. Only one extra ball per ball in play can be given.

The number of balls per game is adjustable. When the last ball enters the outhole, the Game Over and Number to Match lights come on. A random number appears in the ball in play display and if this number matches the last two digits in any player's score a replay is awarded. At this time a High Game to Date score is periodically flashed in all player displays. When a score higher than this is achieved, an award dependent on switches 23 and 24 is given.

Tilting the game results in a penalty depending on the setting of switch 29. There is a normally closed switch on the front door and one on the ball roll assembly. If either of these switches opens from raising the front of the game or pounding the front door, the entire game is ended. The Game Over light comes on and for three seconds the entire switch matrix is inactive.

Additional players can be added at any time the first ball is still in play.

IV. BOOKKEEPING AND SELF-TEST

The circuitry in this game helps the operator perform many bookkeeping functions. The information is shown one step at a time on the first player score display while the step number is shown in the credit display. Pressing the play/test button on the front door begins the bookkeeping and advances it to the next step each time the button is pressed. If the button is not pressed within sixty seconds of each step, the game returns to the attract mode.

STEP NUMBER	INFORMATION SHOWN
00	NONE
01	TOTAL COINS THROUGH LEFT COIN CHUTE
02	TOTAL COINS THROUGH RIGHT COIN CHUTE

NOTE: IF CONTROL BOARD SWITCH 14 IS ON, STEPS 01 AND 02 ARE ADDED TOGETHER AND DISPLAYED IN STEP 01.

03	TOTAL COINS THROUGH CENTER COIN CHUTE

NOTE: FOR GERMAN GAMES ONLY. STEP 02 DISPLAYS TOTAL COINS THROUGH CENTER COIN CHUTE AND STEP 03 DISPLAYS TOTAL COINS THROUGH RIGHT COIN CHUTE.

04	TOTAL PLAYS
05	TOTAL REPLAYS
06	GAME PERCENTAGE (Replays ÷ total plays)

NOTE: IF STEP 06 IS RESET, STEPS 04 AND 05 MUST ALSO BE RESET.

07	EXTRA BALLS
08	TILTS
09	SLAMS
10	Number of times High Game to Date has been incremented to reach its present value.
11	First High Score level
12	Second High Score level
13	Third High Score level
14	High Game to Date score
15	Average playing time per game PLAYER 1 shows minutes PLAYER 2 shows seconds

NOTE: IF STEP 15 IS RESET, STEP 04 MUST ALSO BE RESET.

All bookkeeping information is checked against itself to insure that it is correct. If the data changes for any reason, such as a dead battery, that information will be flashing while it is displayed.

The data in any bookkeeping step may be reset to zero while it is displayed by pressing the replay button on the front door. The play/test button must then be pressed to enter the zero into memory.

TO CHANGE HIGH SCORE LEVELS OR HIGH GAME TO DATE SCORE:

1. Press the play/test button on the front door to advance to step 11. (1st high score level).
2. Reset the score by pressing the replay button on the front door.
3. Release the replay button then hold it in again. This causes the score to advance by 10,000's. Hold in the replay button until the desired score is shown.

   Enter the new score into memory by pressing the play/test button and advancing to the next step.

To return the attract mode at any time, actuate the slam switches, tilt switches, on-off power switch, or wait sixty seconds.

SELF-TEST FEATURES:

The self-test routine begins with STEP 16. To bypass the bookkeeping functions and advance directly to self-test, press the Replay button in STEP 00.

STEP NUMBER	
16	**LAMP TEST** Relays and coin lockout coil are pulsed, then all controlled lamps are turned on in sequence.
17	**SOLENOID TEST** Each controlled solenoid is pulsed while its number appears on the status display.

SOLENOID ASSIGNMENTS

NUMBER	FUNCTION
1	#2 Hole Kicker
2	#1 & #3 Hole Kickers
3	Left Coin Chute counter*
4	Right Coin Chute counter*
5	Left Target Bank Reset
6	Right Target Bank Reset
7	Center Coin Chute counter*
8	Knocker
9	Outhole

*coin counters are optional and are **NOT** pulsed during SOLENOID TEST.

NOTE: FOR GERMAN GAMES ONLY, SOLENOID #4 is assigned to the **center** coin chute counter and SOLENOID #7 is assigned to the **right** coin chute counter.

18 **SWITCH TEST**

All switches on the switch matrix are inspected. If all switches are open, 99 is displayed on the status display. If one or more switches are closed, their numbers will appear on the status displays.

CAUTION: TURN POWER OFF BEFORE MAKING ANY SWITCH ADJUSTMENTS!

19 **DISPLAY TEST**

Each digit of each display is turned on individually and all numbers 0-9 are sequenced.

20 **MEMORY TEST**

Each control board memory device is inspected. Any defective devices are indicated by part number on the PLAYER 1 score display.

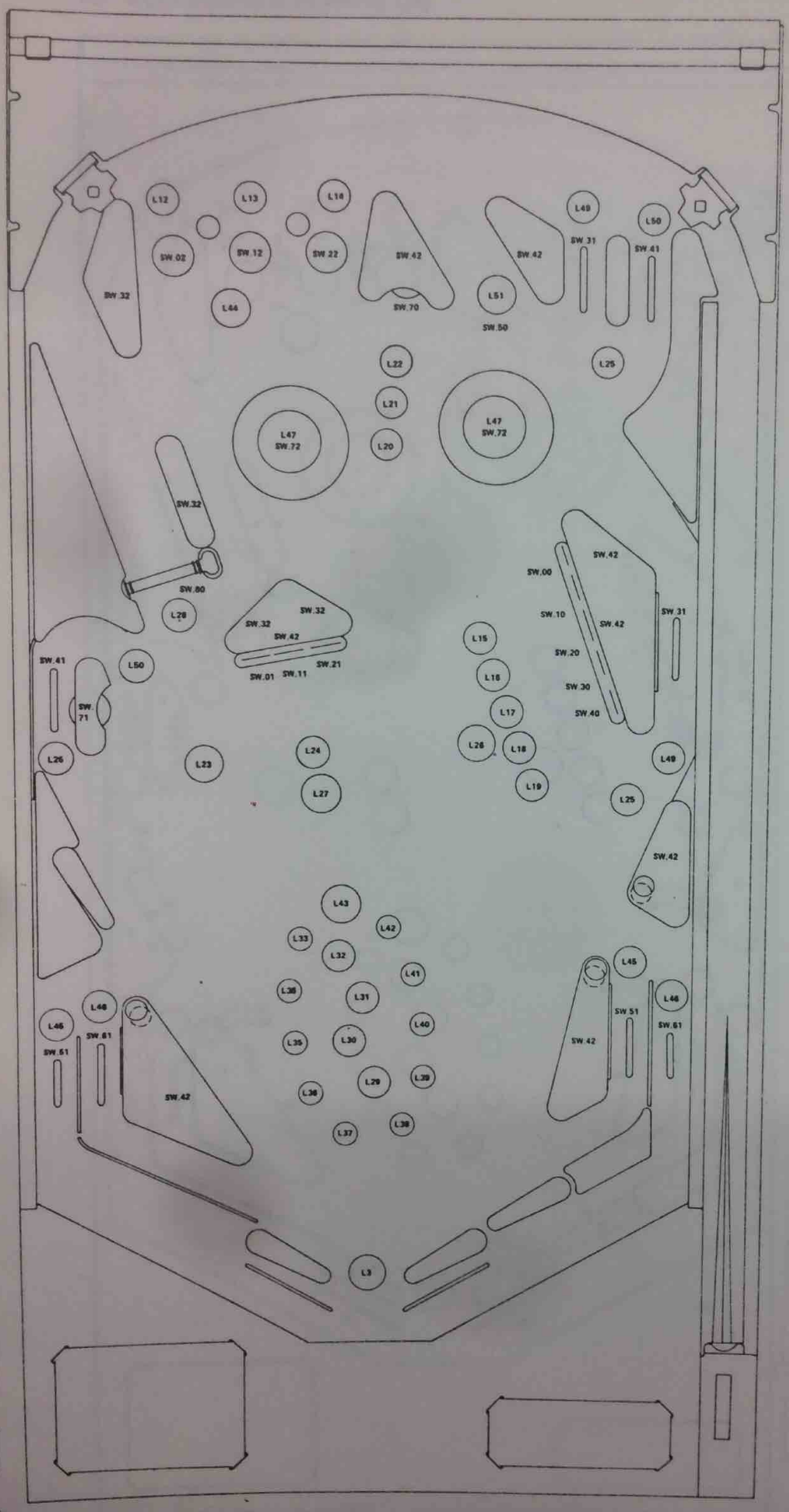
Any of the tests in steps 16 through 20 may be repeated any number of times by pressing the replay button immediately after the test is completed.

V. OPTIONAL ELECTRO-MECHANICAL COIN COUNTERS

Electro-mechanical coin counters may be installed on the bottom board, if desired. Directly behind the seven position fuse block, solder lugs are provided which will connect the counters to the electronic circuitry.

1. Position the counter and secure it to the bottom board. Mounting holes are spotted in the bottom board for most standard 24 volt counters.
2. **CAUTION:** A 1N4004 diode must be connected across each counter with the cathode end connected to the solder lug with the RED-BLACK-BLACK wire.
3. Connect one counter lead to each of the two solder lugs provided for each counter.
4. The counter should increment once when the respective coin chute switch is closed.

VI. SWITCH MATRIX AND LAMP LOCATION ASSIGNMENT



SWITCH MATRIX AND LAMP LOCATION

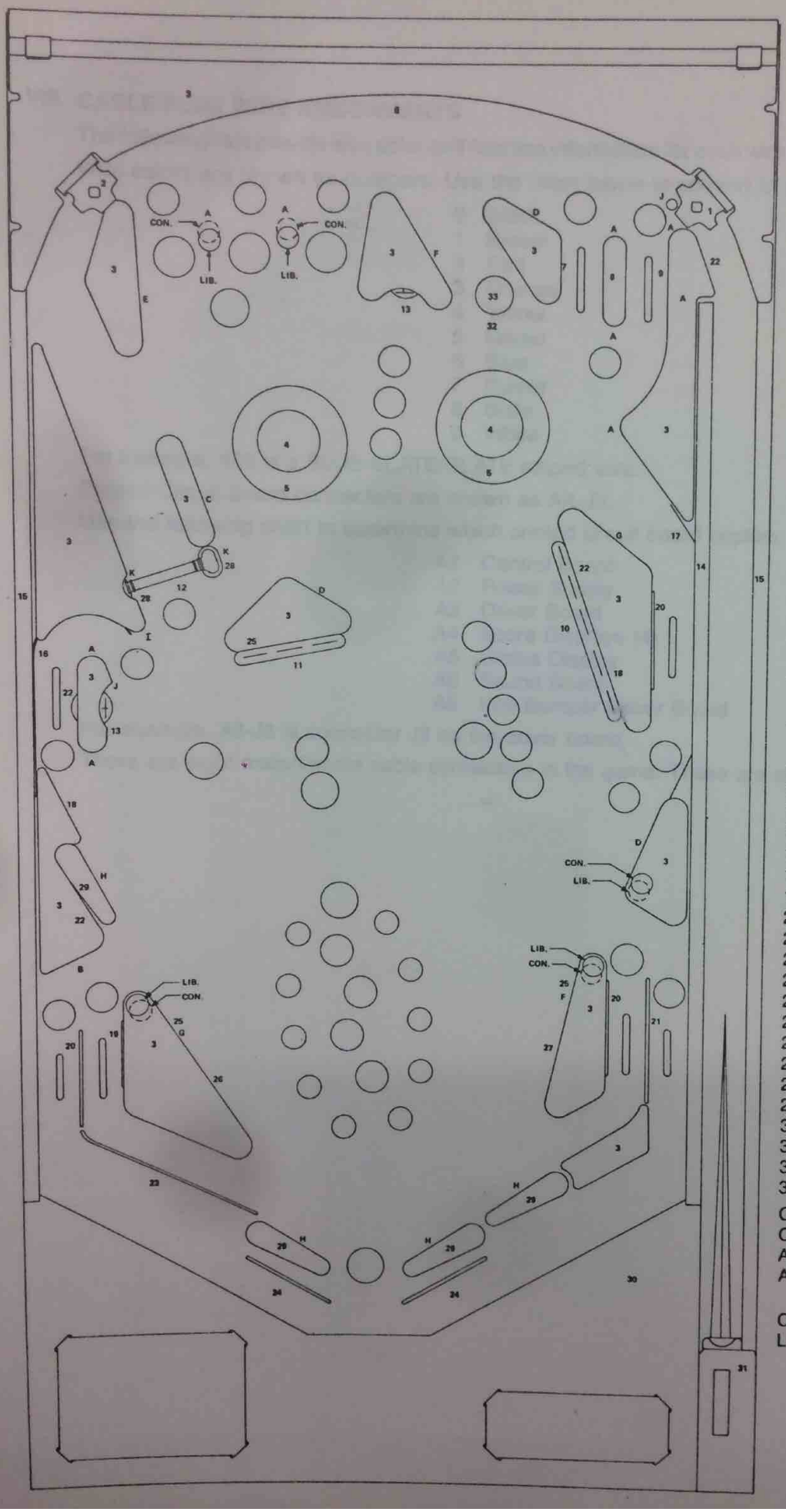
SWITCHES ON MATRIX

SW. MATRIX NUMBER	SWITCH FUNCTION
00	#1 Right Drop Target
01	#1 Left Drop Target
02	#1 Hole
10	#2 Right Drop Target
11	#2 Left Drop Target
12	#2 Hole
20	#3 Right Drop Target
21	#3 Left Drop Target
22	#3 Hole
30	#4 Right Drop Target
31	"A" Rollover (2)
32	10 Point Contacts (4)
40	#5 Right Drop Target
41	"B" Rollover (2)
42	50 Point Contacts (6) Kicking Rubber (2)
50	Rollover Button
51	Right Return Rollover Left Outside Rollover
57	Tilt
60	Spin Target
61	Left Return Rollover Right Outside Rollover
67	Outhole
70	Top Target
71	Side Target
72	Pop Bumpers (2)

CPU CONTROLLED LAMPS

LAMP NUMBER	LAMP FUNCTION
0	Game Over Relay
1	Tilt Relay
2	Coin Lockout Relay
3	Same Player Shoots Again (Lightbox and Playfield)
4	1st Player
5	2nd Player
6	3rd Player
7	4th Player
10	High Game To Date (Lamp in Lightbox)
11	Game Over (Lamp in Lightbox)
12	#1 Hole Kicker
13	#2 Hole Kicker
14	#3 Hole Kicker
15	#1 Right Drop Target
16	#2 Right Drop Target
17	#3 Right Drop Target
18	#4 Right Drop Target
19	#5 Right Drop Target
20	#1 Top Target
21	#2 Top Target
22	#3 Top Target
23	Special
24	Advance Multiplier
25	Multi-Bonus (3)
26	Right Extra Ball
27	Left Extra Ball
28	Spin Target
29	2X
30	3X
31	4X
32	5X
33	1000 Bonus
34	2000 Bonus
35	3000 Bonus
36	4000 Bonus
37	5000 Bonus
38	6000 Bonus
39	7000 Bonus
40	8000 Bonus
41	9000 Bonus
42	10,000 Bonus
43	20,000 Bonus
44	Scores Bonus
45	Right Return Rollover Left Outside Rollover
46	Left Return Rollover Right Outside Rollover
47	Pop Bumpers (2)
49	"A" Rollovers (2)
50	"B" Rollovers (2)
51	Rollover Button

VII. PLAYBOARD INFORMATION



PLAYBOARD INFORMATION

RUBBER RINGS

A—A-10217 (9)
B—A-10219 (1)
C—A-10220 (1)
D—A-10221 (3)
E—A-10222 (1)
F—A-10223 (2)
G—A-10224 (2)
H—A-13151 (4)
I—A-14793 (1)
J—A-15705 (2)
K—A-17493 (2)

PARTS LIST

1. A-19645 Ball Gate Right.
2. A-19646 Ball Gate Left.
3. D-19736 Plastic Shield Set.
4. Red Pop Bumpers A-13905 and A-19771 Cap Stamped in Blue. (2)
5. C-10433 Pop Bumper Skirt Red. (2)
6. D-19649 Arch Rail.
7. A-9393 Yellow Plastic Guide Rail.
8. A-9396 Yellow Plastic Guide Rail.
9. A-9397 Yellow Plastic Guide Rail.
10. 5 Pos. Right Drop Target Bank, A-19838 Stamped in Black.
11. 3 Pos. Left Drop Target Bank A-19838 Stamped in Black.
12. A-19841 Spinning Target Stamped in Black.
13. A-19837 Target Stamped in Black. (2)
14. C-19647 Center Wood Rail.
15. C-19648 Right and Left Outside Rails. (2)
16. B-13602 Metal Flat Rail.
17. B-15609 Metal Flat Rail.
18. A-3722 Ball Guide Rail. (2)
19. A-4831 Ball Guide Rail. (1)
20. A-4832 Ball Guide Rail. (3)
21. A-4833 Ball Guide Rail. (1)
22. A-6931 Ball Guide Rail. (4)
23. A-13584 Ball Guide Rail. (1)
24. A-13798 Ball Snubber Rail. (2)
25. A-18070 Ball Guide Rail. (3)
26. A-15836 Left Kicking Rubber.
27. A-15838 Right Kicking Rubber.
28. C-17492 White Siamese Post. (2)
29. C-13150 White Jumbo Flipper. (4)
30. E-18793 Card Holder.
31. C-9767 Ball Shooter Gage.
32. D-11966 Rollover Insert—Red.
33. D-11968 Rollover Button—White.

C-11561 Clear 1" High Post. (35)
C-11562 Clear 1-3/16" High Post. (4)
A-14487 Split Post Base. (8)
A-14488 Split Post Cap. (8)

CON. = CONSERVATIVE.
LIB. = LIBERAL.

VIII. CABLE PLUG WIRE ASSIGNMENTS

The following lists provide wire color and function information for each wire of each connector in the game.

Wire colors are shown as numbers. Use the chart below to convert to colors.

0	Black
1	Brown
2	Red
3	Orange
4	Yellow
5	Green
6	Blue
7	Purple
8	Slate
9	White

For example, 688 is a BLUE-SLATE-SLATE striped wire.

Printed Circuit Board connectors are shown as AX-JX.

Use the following chart to determine which printed circuit board applies:

A1	Control Board
A2	Power Supply
A3	Driver Board
A4	Score Displays (4)
A5	Status Display
A6	Sound Board
A8	Pop Bumper Driver Board

For example, A3-J3 is connector J3 on the driver board.

There are eight male/female cable connectors in the game. These are shown as A7-JX/PX.

A1-J1

PIN	WIRE COLOR	FUNCTION
1	*688	+5VDC
2	*688	+5VDC
3	—	SPARE
4	*54	GROUND
5	*54	GROUND

A1-J2

PIN	WIRE COLOR	FUNCTION
1	300	aA
2	311	bA
3	322	cA
4	333	dA
5	344	eA
6	355	fA
7	366	gA
8	377	hA
9	600	aB
10	611	bB
11	622	cB
12	633	dB
13	644	eB
14	655	fB
15	666	gB
16	677	hB
17	800	aC
18	811	bC
19	822	cC
20	833	dC
21	844	eC
22	855	fC
23	866	gC
24	877	hC

A1-J3

PIN	WIRE COLOR	FUNCTION
1	400	D1
2	411	D2
3	422	D3
4	433	D4
5	444	D5
6	455	D6
7	466	D7
8	477	D8
9	700	D9
10	711	D10
11	722	D11
12	733	D12
13	744	D13
14	755	D14
15	766	D15
16	777	D16
17	—	SPARE

A1-J4

PIN	WIRE COLOR	FUNCTION
1	*54	GROUND
2	*688	+5VDC
3	9	DS2
4	9	LD3
5	9	LD4
6	9	LD2
7	9	LD1
8	—	SPARE
9	—	SPARE
10	—	SPARE
11	—	SPARE
12	—	SPARE
13	—	SPARE
14	—	SPARE
15	—	SPARE
16	—	SPARE
17	—	SPARE
18	—	KEY
19	—	SPARE
20	—	SPARE
21	9	KNOCKER
22	9	3RD COUNTER
23	9	2ND COUNTER
24	9	1ST COUNTER
A	*54	GROUND (SPARE)
B	*688	+5VDC (SPARE)
C	9	DS1
D	9	DS4
E	9	DS3
F	9	DS6
H	9	DS5
J	9	DS8
K	9	DS7
L	9	DS10
M	9	DS9
N	9	DS11
P	9	DS12
R	9	SOLENOID 5
S	9	SOLENOID 1
T	9	OUTHOLE
U	9	SOLENOID 6
V	—	(KEY)
W	—	SPARE
X	9	SOLENOID 2
Y	9	SOUND 8
Z	9	SOUND 4
A	9	SOUND 2
B	9	SOUND 1

ALL WIRES #22 GAUGE UNLESS SPECIFIED* (18 GA.)

A1-J5

PIN	WIRE COLOR	FUNCTION
1	677	RETURN 7
2	400	STROBE 0
3	411	STROBE 1
4	422	STROBE 2
5	433	STROBE 3
6	*444	STROBE 4
7	455	STROBE 5
8	666	RETURN 6
9	477	STROBE 7
10	700	SLAM SW.

A1-J6

PIN	WIRE COLOR	FUNCTION
1	400	STROBE 0
2	411	STROBE 1
3	422	STROBE 2
4	433	STROBE 3
5	444	STROBE 4
6	455	STROBE 5
7	466	STROBE 6
8	477	STROBE 7
9	9	GROUND
10	600	RETURN 0
11	611	RETURN 1
12	622	RETURN 2
13	633	RETURN 3
14	644	RETURN 4
15	655	RETURN 5
16	666	RETURN 6
17	677	RETURN 7
18	688	+5VDC
19	—	SPARE

A2-J1

PIN	WIRE COLOR	FUNCTION
1	(#16GA) 200	12VDC
2	(#16GA) 54	GROUND
3	—	SPARE
4	—	(KEY)
5	688	+5VDC
6	166	+5VDC offset
7	100	60V
8	111	60V RETURN
9	133	+8VDC offset

A2-J2

PIN	WIRE COLOR	FUNCTION
1	*688	+5VDC
2	*688	+5VDC
3	*54	GROUND
4	*54	GROUND
5	—	(KEY)
6	—	SPARE

A2-J3

PIN	WIRE COLOR	FUNCTION
1	044	+60VDC
2	—	(KEY)
3	055	+42VDC
4	54	GROUND
5	54	GROUND
6	688	+5VDC (SPARE)
7	688	+5VDC

A3-J1

PIN	WIRE COLOR	FUNCTION
1	*54	GROUND
2	*688	+5VDC
3	9	DS2
4	9	LD3
5	9	LD4
6	9	LD2
7	9	LD1
8	—	SPARE
9	—	SPARE
10	—	SPARE
11	—	SPARE
12	—	SPARE
13	—	SPARE
14	—	SPARE
15	—	SPARE
16	—	SPARE
17	—	SPARE
18	—	SPARE
19	—	(KEY)
20	—	SPARE
21	9	KNOCKER
22	9	3RD COUNTER
23	9	2ND COUNTER
24	9	1ST COUNTER
A	*54	GROUND (SPARE)
B	*688	+5VDC (SPARE)
C	9	DS1
D	9	DS4
E	9	DS3
F	9	DS6
H	9	DS5
J	9	DS8
K	9	DS7
L	9	DS10
M	9	DS9
N	9	DS11
P	9	DS12
R	9	SOLENOID 5
S	9	SOLENOID 1
T	9	OUTHOLE
U	9	SOLENOID 6
V	—	SPARE
W	—	(KEY)
X	9	SOLENOID 2
Y	9	SOUND 8
Z	9	SOUND 4
$\overline{A}$	9	SOUND 2
$\overline{B}$	9	SOUND 1

ALL WIRES #22 GAUGE UNLESS SPECIFIED* (18 GA.)

A3-J2

PIN	WIRE COLOR	FUNCTION
1	588	SHOOT AGAIN LAMP
2	500	PLAYER 1 LAMP
3	511	PLAYER 2 LAMP
4	533	PLAYER 4 LAMP
5	522	PLAYER 3 LAMP
6	*54	GROUND
7	577	HIGH GAME TO DATE LAMP
8	566	GAME OVER LAMP
9	—	SPARE
10	—	SPARE

A3-J3

PIN	WIRE COLOR	FUNCTION
1	*54	SPARE GROUND
2	777	L43
3	755	L41
4	744	L40
5	544	L32
6	555	L33
7	577	L35
8	—	KEY
9	344	L24
10	355	L25
11	377	L27
12	366	L26
13	144	L16
14	155	L17
15	177	L19
16	166	L18
17	(16GA) 54	GROUND (L20-L27)
18	322	L22
19	333	L23
20	311	L21
21	300	L20
22	122	L14
23	133	L15
24	111	L13
25	100	L12
A	*54	SPARE GROUND
B	*688	+5VDC (SPARE)
C	*54	GROUND (L44-L51)
D	800	L44
E	844	L48
F	811	L45
H	855	L49
J	—	KEY
K	566	L34
L	—	SPARE
M	833	L47
N	877	L51
P	822	L46
R	866	L50

continued

A3-J3 continued

PIN	WIRE COLOR	FUNCTION
S	*54	GROUND (L40-L43)
T	766	L42
U	(16GA) 54	GROUND (L28-L35)
V	522	L30
W	533	L31
X	511	L29
Y	500	L28
Z	(16GA) 54	GROUND (L12-L19)
Ā	288	GAME OVER RELAY
B̄	277	TILT RELAY
C̄	588	SHOOT AGAIN LAMP

A3-J4

PIN	WIRE COLOR	FUNCTION
1	700	L36
2	711	L37
3	733	L39
4	722	L38
5	*54	GROUND (L36-L39)
6	*211	SOLENOID 5
7	*266	SOLENOID 1
8	*244	OUTHOLE (SOL. 9)
9	*54	GROUND (SOL. 1, 9)
10	*54	GROUND (SOL. 2)
11	*54	GROUND (SOL. 6)
12	*233	SOLENOID 6
13	*200	SOLENOID 2
14	*54	GROUND (SOL. 5)
15	*54	SPARE GROUND

A3-J5

PIN	WIRE COLOR	FUNCTION
1	733	SOUND 4
2	877	COIN LOCKOUT COIL
3	54	GROUND (KNOCKER)
4	688	+5VDC (SPARE)
5	722	SOUND 2
6	711	SOUND 1
7	744	SOUND 8
8	888	KNOCKER

A3-J6

PIN	WIRE COLOR	FUNCTION
1	633	2ND COUNTER
2	644	3RD COUNTER
3	655	1ST COUNTER
4	54	GROUND

ALL WIRES #22 GAUGE UNLESS SPECIFIED* (18 GA.)

1A4-J1

PIN	WIRE COLOR	FUNCTION
1	455	D6
2	444	D5
3	433	D4
4	422	D3
5	411	D2
6	400	D1
7	377	hA
8	366	gA
9	355	fA
10	344	eA
11	333	dA
12	322	cA
13	311	bA
14	300	aA
15	122	5VAC
16	144	5VAC RETURN
17	044	+60VDC
18	—	SPARE
19	54	GROUND

2A4-J1

PIN	WIRE COLOR	FUNCTION
1	733	D12
2	722	D11
3	711	D10
4	700	D9
5	477	D8
6	466	D7
7	377	hA
8	366	gA
9	355	fA
10	344	eA
11	333	dA
12	322	cA
13	311	bA
14	300	aA
15	122	5VAC
16	144	5VAC RETURN
17	044	+60VDC
18	—	SPARE
19	54	GROUND

3A4-J1

PIN	WIRE COLOR	FUNCTION
1	455	D6
2	444	D5
3	433	D4
4	422	D3
5	411	D2
6	400	D1
7	677	hB
8	666	gB
9	655	fB
10	644	eB
11	633	dB
12	622	cB
13	611	bB
14	600	aB
15	122	5VAC
16	144	5VAC RETURN
17	044	+60VDC
18	—	SPARE
19	54	GROUND

4A4-J1

PIN	WIRE COLOR	FUNCTION
1	733	D12
2	722	D11
3	711	D10
4	700	D9
5	477	D8
6	466	D7
7	677	hB
8	666	gB
9	655	fB
10	644	eB
11	633	dB
12	622	cB
13	611	bB
14	600	aB
15	122	5VAC
16	144	5VAC RETURN
17	044	+60VDC
18	—	SPARE
19	54	GROUND

ALL WIRES #22 GAUGE UNLESS SPECIFIED* (18 GA.)

A5-J1

PIN	WIRE COLOR	FUNCTION
1	—	SPARE
2	777	D16
3	766	D15
4	—	SPARE
5	755	D14
6	744	D13
7	822	cC
8	811	bC
9	877	hC
10	866	gC
11	855	fC
12	844	eC
13	833	dC
14	800	aC
15	155	3vAC
16	177	3vAC RETURN
17	055	+42vDC
18	688	+5vDC
19	54	GROUND

A6-J1

PIN	WIRE COLOR	FUNCTION
1	200	+12vDC
2	—	SPARE
3	333	AC
4	344	AC RETURN
5	688	+5vDC
6	54	GROUND
7	011	SPEAKER OUTPUT
8	711	SOUND 1
9	722	SOUND 2
10	—	SPARE
11	733	SOUND 4
12	744	SOUND 8

A7-J1/P1

PIN	WIRE COLOR	FUNCTION
1	677	RETURN 7
2	500	STROBE 0
3	511	STROBE 1
4	533	STROBE 3
5	522	STROBE 2
6	544	STROBE 4
7	555	STROBE 5
8	—	SPARE
9	—	SPARE
10	700	ANTI-CHEAT SW.
11	9	ANTI-CHEAT SW. (GND)
12	*54	EARTH GROUND

A7-J2/P2

PIN	WIRE COLOR	FUNCTION
1	*066	COIN CHUTE LIGHTS
2	*000	COIN CHUTE LIGHTS RETURN
3	*055	LEFT FLIPPER SWITCH
4	*388	FLIPPER SWITCH RETURN
5	222	+24vDC
6	877	COIN LOCKOUT

A7-J3/P3

PIN	WIRE COLOR	FUNCTION
1	*122	5VAC
2	*144	5VAC RETURN
3	155	3VAC
4	177	3VAC RETURN
5	*54	LAMP GROUND
6		SPARE
7	(16GA) 077	6.3 VAC
8	(16GA) 000	6.3 VAC RETURN
9	*255	+6vDC

A7-J4/P4

PIN	WIRE COLOR	FUNCTION
1	*54	GROUND
2	*54	GROUND
3	*54	GROUND
4	*54	GROUND
5	*54	GROUND
6	*54	GROUND
7	*54	GROUND
8	*54	GROUND
9	*54	GROUND
10	*54	GROUND
11	*54	GROUND
12	—	SPARE

A7-J5/P5

PIN	WIRE COLOR	FUNCTION
1	(16GA) 255	+6 VDC
2	(16GA) 54	GROUND
3	(16GA) 54	GROUND
4	(16GA) 54	GROUND
5	(16GA) 54	GROUND
6	(16GA) 222	+24VDC
7	*388	FLIPPER SW. RETURN
8	*388	FLIPPER SW. RETURN
9	*055	LEFT FLIPPER SWITCH
10	*044	RIGHT FLIPPER SWITCH
11	(16GA) 066	6.3VAC
12	(16GA) 000	6.3VAC RETURN
13	*277	25VAC
14	*288	25VAC RETURN
15	—	SPARE

ALL WIRES #22 GAUGE UNLESS SPECIFIED* (18 GA.)

A7-J6/P6

PIN	WIRE COLOR	FUNCTION
1	011	MATCH LIGHT
2	022	TILT LIGHT
3	033	BALL IN PLAY LIGHT
4	—	SPARE

A7-J7/P7

PIN	WIRE COLOR	FUNCTION
1	400	STROBE 0
2	433	STROBE 3
3	477	STROBE 7
4	666	RETURN 6
5	677	RETURN 7
6	(#16GA) 54	GROUND
7	—	SPARE
8	777	AC INPUT
9	788	AC INPUT

A7-J8/P8

PIN	WIRE COLOR	FUNCTION
1	022	SPEAKER
2	*54	GROUND
3	*54	EARTH GROUND
4	—	SPARE

1A8-J1

PIN	WIRE COLOR	FUNCTION
1	*188	COIL #1
2	*54	GROUND
3	—	KEY
4	077	SWITCH #1
5	688	+5VDC
6	9	DC GROUND

2 A8-J1

PIN	WIRE COLOR	FUNCTION
1	*488	COIL #2
2	*54	GROUND
3	—	KEY
4	011	SWITCH #2
5	688	+5VDC
6	9	DC GROUND

ALL WIRES #22 GAUGE UNLESS SPECIFIED* (18 GA.)

IX. PARTS LIST

CONTROL BOARD

PART NUMBER	DESCRIPTION
R6502-13	CPU—(U1)
R6532-18	RIOT—(U4, U5, U6)
R3273-12	ROM—(U2)
R3272-12	ROM—(U3)
P5101L-1	RAM/CMOS—(Z5)
640361-3	SOCKET—DIP, 24 PIN
SN7402N	IC—2 INPUT—"NOR"—(Z8)
SN7400N	IC—2 INPUT—"NAND"—(Z9, Z13, Z14)
SN7432N	IC—2 INPUT—"OR"—(Z15)
SN7404N	IC—HEX INVERTER—(*)
SN7416N	IC—HEX INVERTER—OC/HV—(Z29, Z30)
SN7417N	IC—HEX BUFFER—OC—(Z32)
SN74LS139N	IC—2 TO 4 DECODER—(Z28)
SN74175N	IC—"D" FLIP FLOP—(Z18, Z20, Z22)
SN7448N	IC—4 TO 7 DECODER—(Z19, Z21, Z23)
SN74154N	IC—4 TO 16 DECODER—(Z25, Z33)
SN7474N	IC—DUAL FLIP FLOP—(Z2)
SCL4528B	CMOS IC—DUAL 1 SHOT—(Z1)
SCL4081B	CMOS IC—QUAD 2 INPUT "AND"—(Z4)
1N4148	DIODE—GP—(CR1-CR35)
1N5225B or 1N5987B	ZENER DIODE—3.0V, 5%—(VR1)
326R10-002	BATTERY—3.6V—(BAT. 1)
333R08-001	CRYSTAL—3.579545 MHZ—(Y1)
131R06-001	SPACER, CORK
MPS A70	TRANSISTOR—PNP—(Q1, Q4)
341R31-005	DIP SWITCH PACK—8 POS.—(SW1-SW4)
	RESISTOR—62Ω, ¼W, 5%—(R7)
	CAPACITOR—.01 MICROFARAD, 50V—(C2, C4-C13, C15-C24, C26-C29, C31-C35)
	CAPACITOR—.1 MICROFARAD, 50V—(C3, C14, C25, C30)
	CAPACITOR—100 MICROFARAD, 10V—(C1)
	RESISTOR—3.0KΩ, ¼W, 5%—(R1, R3, R6, R11-24, R42, R45, R46, R48, R51-R57)
	RESISTOR—2.0KΩ, ¼W, 5%—(R4, R5, R44)
	RESISTOR—180Ω, ¼W, 5%—(R8, R50)
	RESISTOR—1KΩ, ¼W, 5%—(R9)
	RESISTOR—2.7MΩ, ¼W, 5%—(R10)
	RESISTOR—620Ω, ¼W, 5%—(R25-R33)
	RESISTOR—4.7KΩ, ¼W, 5%—(R2, R34-R41)
	RESISTOR—5.6KΩ, ¼W, 5%—(R43, R49)
	RESISTOR—24KΩ, ¼W, 5%—(R47)
	CAPACITOR—10 MICROFARAD, 10V—(C36)
2N4400	TRANSISTOR—MOTOROLA—(Q2, Q3)
SN74LS05N	IC—OPEN COLLECTOR INVERTER—(Z10)
SN74LS04N	IC—HEX INVERTER—(Z7)
MM74C04 or SCL 4069B	IC—CMOS—(Z36)
640379-3	SOCKET—40 PIN—(TC1)

*(Z3, Z11, Z12, Z16, Z17, Z24, Z26, Z27, Z34, Z35)

MASTER DRIVER BOARD

PART NUMBER	DESCRIPTION
43-03-4	INSULATOR—THERMALLOY
2N6043	TRANSISTOR—NPN—(Q53, Q59, Q60)
2N3055	TRANSISTOR—NPN—(Q58, Q62, Q64)
MPS-U45	TRANSISTOR—NPN—(Q1-Q4, Q13-Q32, Q45-Q52, Q54-Q57, Q61, Q63)
MPS-A13	TRANSISTOR—NPN—(Q5-Q12, Q33-Q44)
SN74175N	IC—QUAD "D" FLIP-FLOP—(Z1-Z12)
SN7404N	IC—HEX INVERTER—(Z32)
1N4148	DIODE—SILICON—(CR1-CR6)
	CAPACITOR—.01 MICROFARAD, 50V—(C2-C19)
	CAPACITOR—10 MICROFARAD, 10V—TANTALUM—(C1)
	RESISTOR—1000Ω, ¼W, 5%—(R1-R53, R61, R55, R56, R58, R59)
	RESISTOR—9.1Ω, 1W, 5%—(R54, R57, R60)

POWER SUPPLY

PART NUMBER	DESCRIPTION
	HEATSINK MOUNTING PLATE
	SPACER—6—32 THREAD X 5/32
	SPACER—6—32 THREAD X ⅛
1N4004	DIODE—(CR1-CR4)
1N4759A	ZENER DIODE—62V, 1W, 5%—(CR5)
1N4746A	ZENER DIODE—18V, 1W, 5%—(CR6)
1N3445	ZENER DIODE—8.2V, 2W, 10%—(CR7)
1N4734A	ZENER DIODE—5.6V, 1W, 5%—(CR8)
SW4F013	TRANSISTOR—NPN—NATIONAL—(Q1)
2N5550	TRANSISTOR—NPN—(Q2)
PMD10K40	TRANSISTOR—LAMBDA—(Q3)
S107Y1	SILICON CONTROLLED RECTIFIER—(SCR1)
UA723CN	IC—14 PIN DIP—(IC1)
CM4-22	DIODE—LIGHT EMITTING—(LED1, LED2)
115R501A	POTENTIOMETER—500Ω—CTS—(POT1)
	RESISTOR—1.3KΩ, 5W, 10%—(R1)
	RESISTOR—1KΩ, ¼W, 5%—(R2, R9)
	RESISTOR—12KΩ, ½W, 5%—(R3)
	RESISTOR—33Ω, 1W, 5%—(R4)
	RESISTOR—510Ω, ¼W, 5%—(R6, R13)
	RESISTOR—3.9KΩ, ¼W, 5%—(R7)
	RESISTOR—10KΩ, ¼W, 5%—(R8)
	RESISTOR—30Ω, 2W, 5%—(R10)
	RESISTOR—2.2KΩ, ¼W, 5%—(R11)
	RESISTOR—.33Ω, 5W, 10%—(WIRE WOUND)—(R12)
	RESISTOR—10KΩ, ½W, 5%—(R5)
	RESISTOR—2KΩ, ¼W, 5%—(R14)
	RESISTOR—100Ω, ¼W, 5%—(R15)
	RESISTOR—20Ω, ¼W, 5%—(R16)
	RESISTOR—620Ω, ½W, 5%—(R17)
	RESISTOR—180Ω, ¼W, 5%—(R18)
	CAPACITOR—470 MICROFARAD, 100V—(C1)
	CAPACITOR—47 MICROFARAD, 100V—(C2)
	CAPACITOR—1000 PICOFARAD, 50V—(C3)
	CAPACITOR—470 MICROFARAD, 10V—(C4)
	CAPACITOR—.2 MICROFARAD, 16V, $^{+80\%}_{-20\%}$—(C5)
	TURRET TERMINAL—(E1-E6)
	TURRET TERMINAL—(TP1-TP5, CR5)
1NS-3	INSULATOR
DM111	INSULATOR
G52-3	EYELET
	CONNECTOR—6 PIN—MOLEX—(J2)
	CONNECTOR—7 PIN—MOLEX—(J3)
	CONNECTOR—9 PIN—MOLEX—(J1)
	HEAT SINK—THERMALLOY

SOUND BOARD

PART NUMBER	DESCRIPTION
	RESISTOR—2.7KΩ, ¼W, 5%—(R1, R2, R7)
	RESISTOR—2.7Ω, ¼W, 5%—R9)
	RESISTOR—6.8KΩ, ¼W, 5%—(R10)
	RESISTOR—430Ω, ½W, 5%—(R11)
	RESISTOR—2.7MΩ, ¼W, 5%—(R3)
	RESISTOR—1.8MΩ, ¼W, 5%—(R4)
	RESISTOR—22.1KΩ, ¼W, 1%—(R12)
	RESISTOR—10KΩ, ¼W, 5%—(R6)
	RESISTOR—5.6KΩ, ¼W, 5%—(R8)
	RESISTOR—270KΩ, ¼W, 5%—(R5)
	RESISTOR—15KΩ, ¼W, 5%—(R13)
	CAPACITOR—0.01 MICROFARAD, 100V, 20%—KEMET—(C1-C5)
	CAPACITOR—47 MICROFARAD, 25V—(C7, C9)
	CAPACITOR—470 MICROFARAD, 25V—(C8)
	CAPACITOR—0.1 MICROFARAD, 100V, 20%—KEMET—(C6, C10, C13, C17)
	CAPACITOR—10 PICOFARAD, 1000V, 5%—(C11)
	CAPACITOR—100 PICOFARAD, 250V, 20%—(C12)
	CAPACITOR—0.047 MICROFARAD, 25V, 20%—(C15)
	CAPACITOR—0.0033 MICROFARAD, 50V, 20%—(C16)
	CAPACITOR—10 MICROFARAD, 25V—(C14)
R6503	IC—CPU—(U1)
R6530C:R3014-14	IC—ROM/RAM/I/O—(U2)
SSS1408-6P	IC—DAC—(U3)
HM7643-5	IC—PROM—(U4)
NE555P	IC—TIMER—(U8)
SN7404N	IC—INVERTER—(U6, U7)
LM380N	IC—AMPLIFIER—(U5)
1N4004	DIODE—(CR1-CR4)
1N4742A	ZENER DIODE—12V, 1W, 5%—(CR5)
1N270	DIODE—(CR6)
76SB02	2 POSITION DIP SWITCH—(S1, S2)
EVQ-PAR-11K	PUSH BUTTON SWITCH—(S3)
640359-1	SOCKET, 18 PIN (PROM SOCKET)

POP BUMPER DRIVER BOARD

PART NUMBER	DESCRIPTION
	CAPACITOR—47 MICROFARAD, 10V—(C4)
	CAPACITOR—0.01 MICROFARAD, 100V, 20%—(C1, C2)
	CAPACITOR—4.7 MICROFARAD, 10V, 10%—(C3)
	RESISTOR—1.5KΩ, ¼W, 5%—(R1)
	RESISTOR—12KΩ, ¼W, 5%—(R2)
	RESISTOR—220Ω, ¼W, 5%—(R3)
1N4148	DIODE—(CR1, CR2)
SN74121N	IC—(Z1)
SN7416N	IC—(Z2)
PMD10K60	TRANSISTOR—LAMBDA—(Q1)
09-65-1061	CONNECTOR—(J1)

6-DIGIT DISPLAY (SPRAGUE DRIVERS)

QUANTITY	NUMBER	DESCRIPTION
1	RC20GF103	Resistor—10KΩ, ½W, 5% (R1)
1	TE1400	Capacitor—1 Microfarad, 100V (C3)
2	C320C103MIR5CA	Capacitor—0.01 Microfarad, 100V—Kemet (C1, C2)
2	UDN6118A	IC—Fluorescent Display Driver—Sprague (Z1, Z2)
1	6-JS-01	6-digit Display Tube—Futaba (DS1)

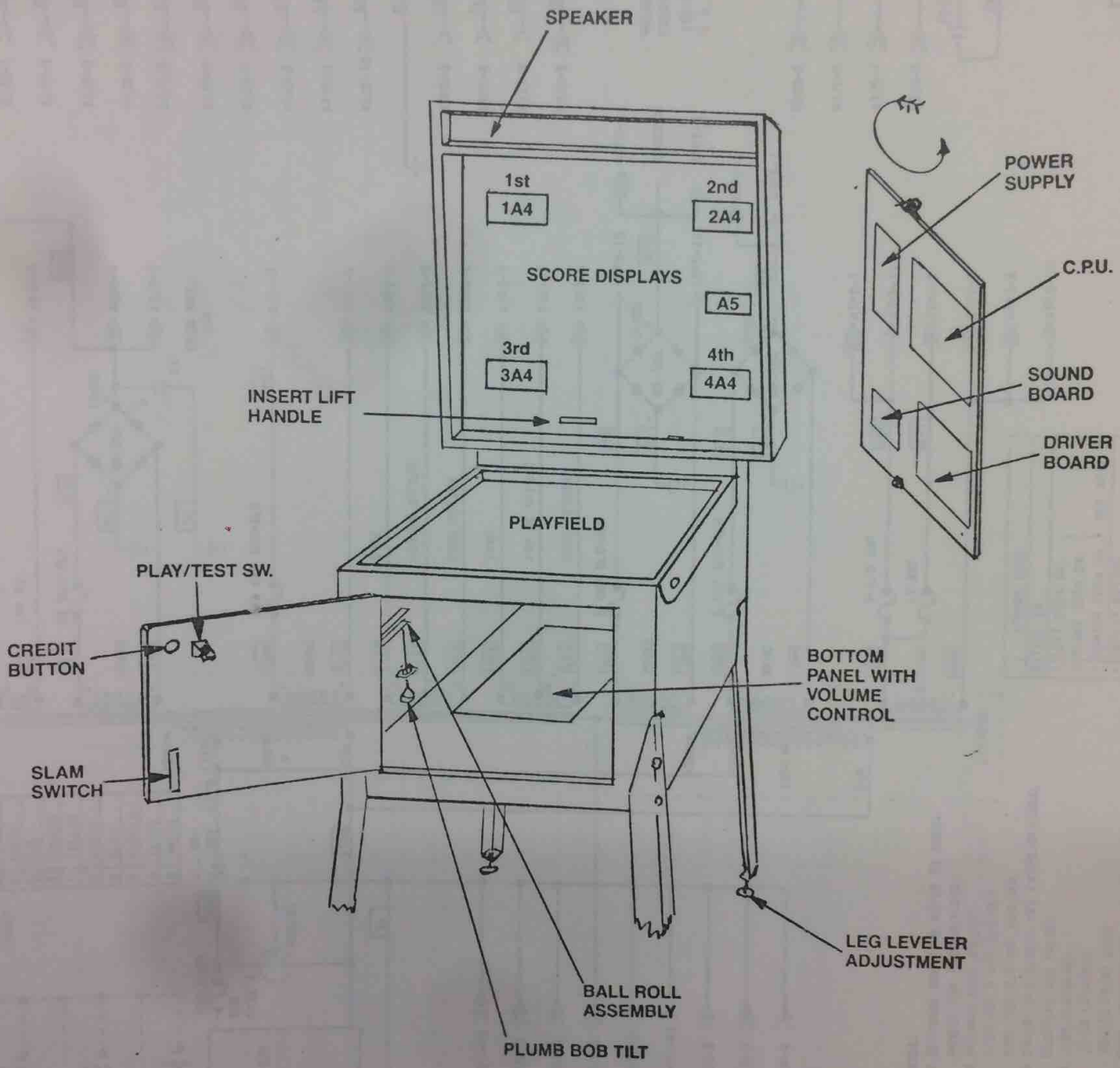
4-DIGIT DISPLAY

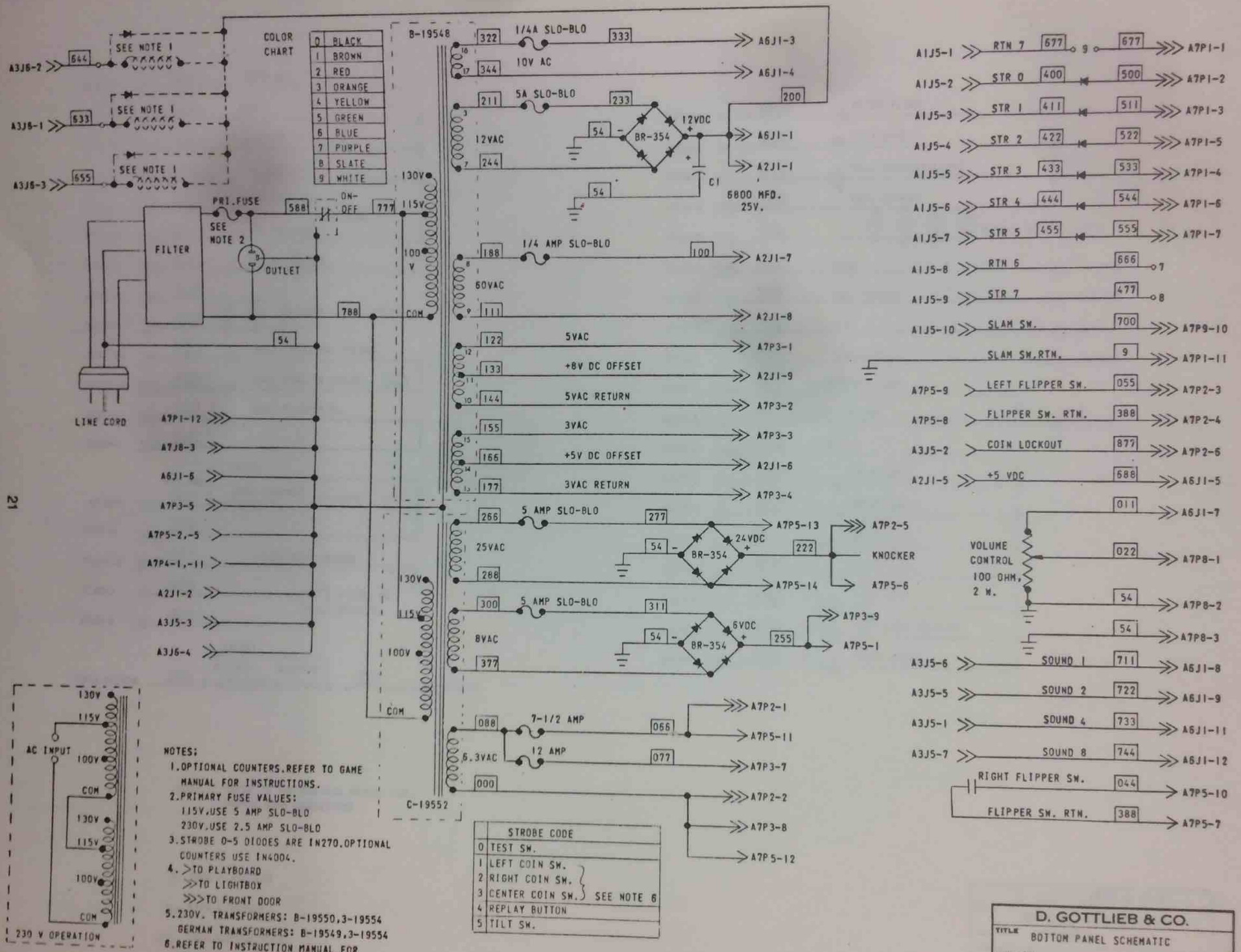
QUANTITY	NUMBER	DESCRIPTION
1	TE1400	Capacitor—1 Microfarad, 100V—Sprague (C-1)
2	C320C103MIR5CA	Capacitor—0.01 Microfarad, 100V—Kemet (C2, C3)
2	UDN6118A	IC—Fluorescent Display Driver—Sprague (Z2, Z3)
1	SN7432N	IC—Quad OR Gate—T.I. (Z1)
1	4-LT-11	4-digit Display Tube—Futaba (DS1)
2	721R01-113	Resistor—4.7KΩ, ¼W, 5% (R1, R2)

X. WIRING AND SCHEMATIC DIAGRAMS

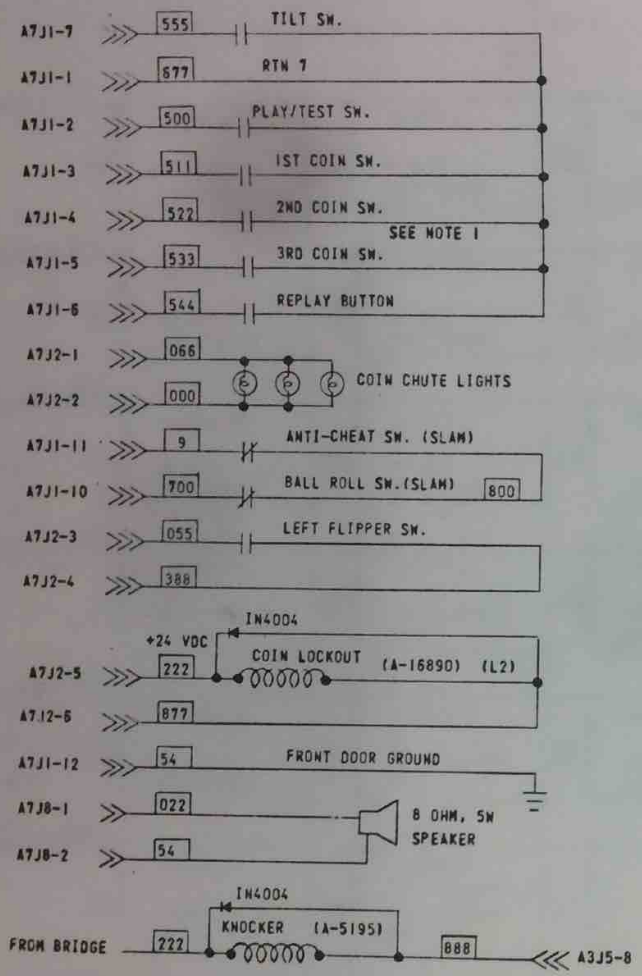
A. COMPONENT LOCATION DIAGRAM
B. BOTTOM BOARD SCHEMATIC
C. BOTTOM BOARD AND LIGHTBOX SCHEMATIC
D. SWITCH MATRIX ASSIGNMENT DIAGRAM
E. PLAYBOARD SOLENOID SCHEMATIC DIAGRAM
F. PLAYBOARD ILLUMINATION SCHEMATIC DIAGRAM
G. LIGHTBOX CABLE SCHEMATIC DIAGRAM
H. CONTROL BOARD COMPONENT LOCATION DIAGRAM
I. CONTROL BOARD SCHEMATIC DIAGRAM 1 OF 2
J. CONTROL BOARD SCHEMATIC DIAGRAM 2 OF 2
K. DRIVER BOARD COMPONENT LOCATION DIAGRAM
L. DRIVER BOARD SCHEMATIC DIAGRAM
M. 6 DIGIT DISPLAY SCHEMATIC AND COMPONENT LOCATION DIAGRAM
N. 4 DIGIT DISPLAY SCHEMATIC AND COMPONENT LOCATION DIAGRAM
O. POWER SUPPLY SCHEMATIC DIAGRAM
P. SOUND BOARD SCHEMATIC DIAGRAM
Q. SOUND BOARD COMPONENT LOCATION DIAGRAM
R. POP BUMPER DRIVER BOARD SCHEMATIC DIAGRAM

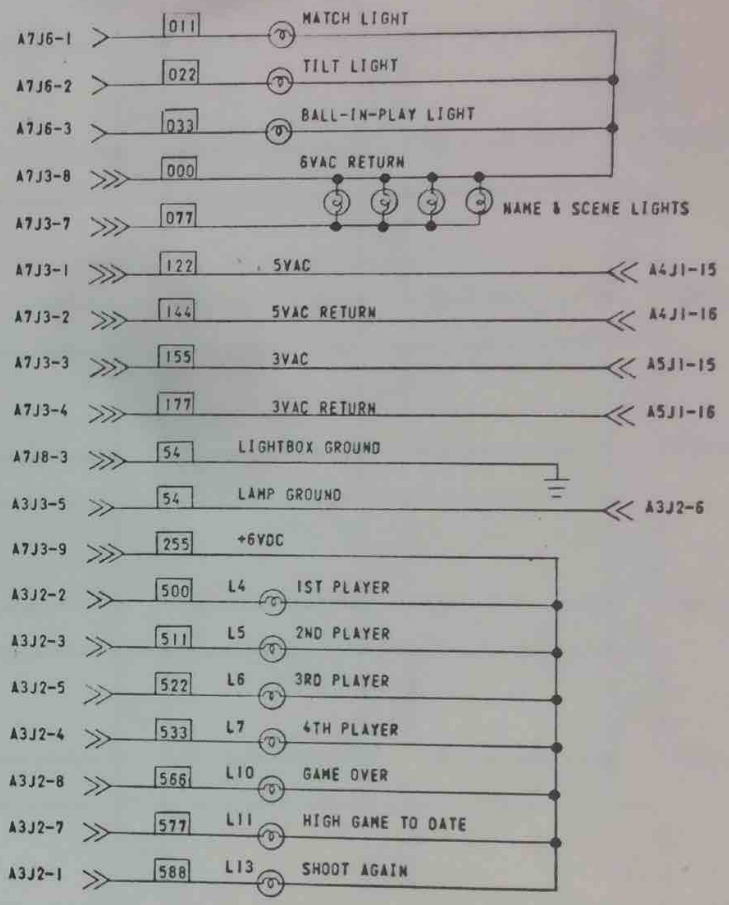
X. A. COMPONENT LOCATION DIAGRAM





D. GOTTLIEB & CO.			
TITLE: BOTTOM PANEL SCHEMATIC			
USED ON:			
DRAWN	APPROVED	DATE	C-19686





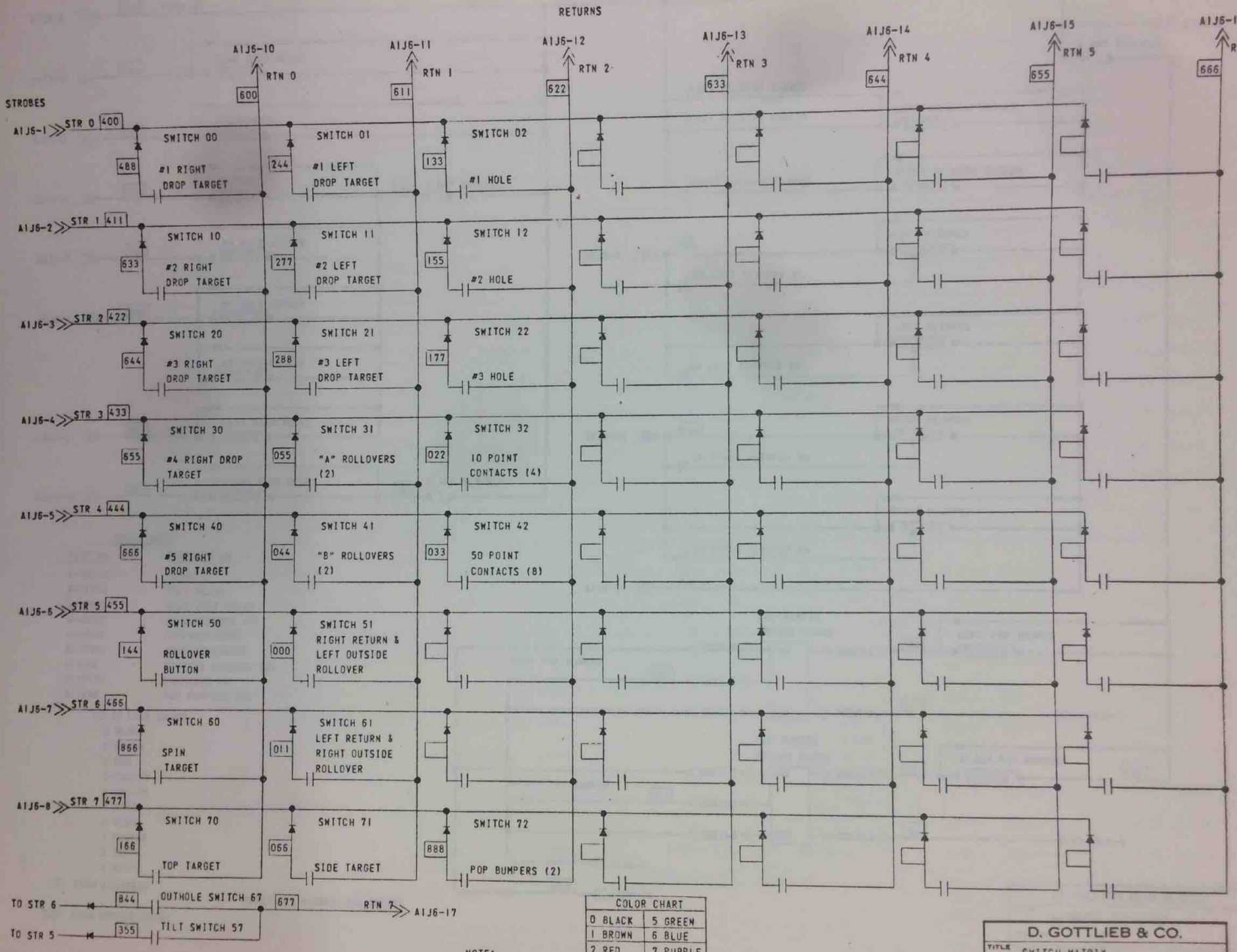
NOTE 1: REFER TO INSTRUCTION MANUAL FOR GARMAN GAME VARIATIONS.

> FROM PLAYBOARD

>> FROM LIGHTBOX

>>> FROM BOTTOM BOARD

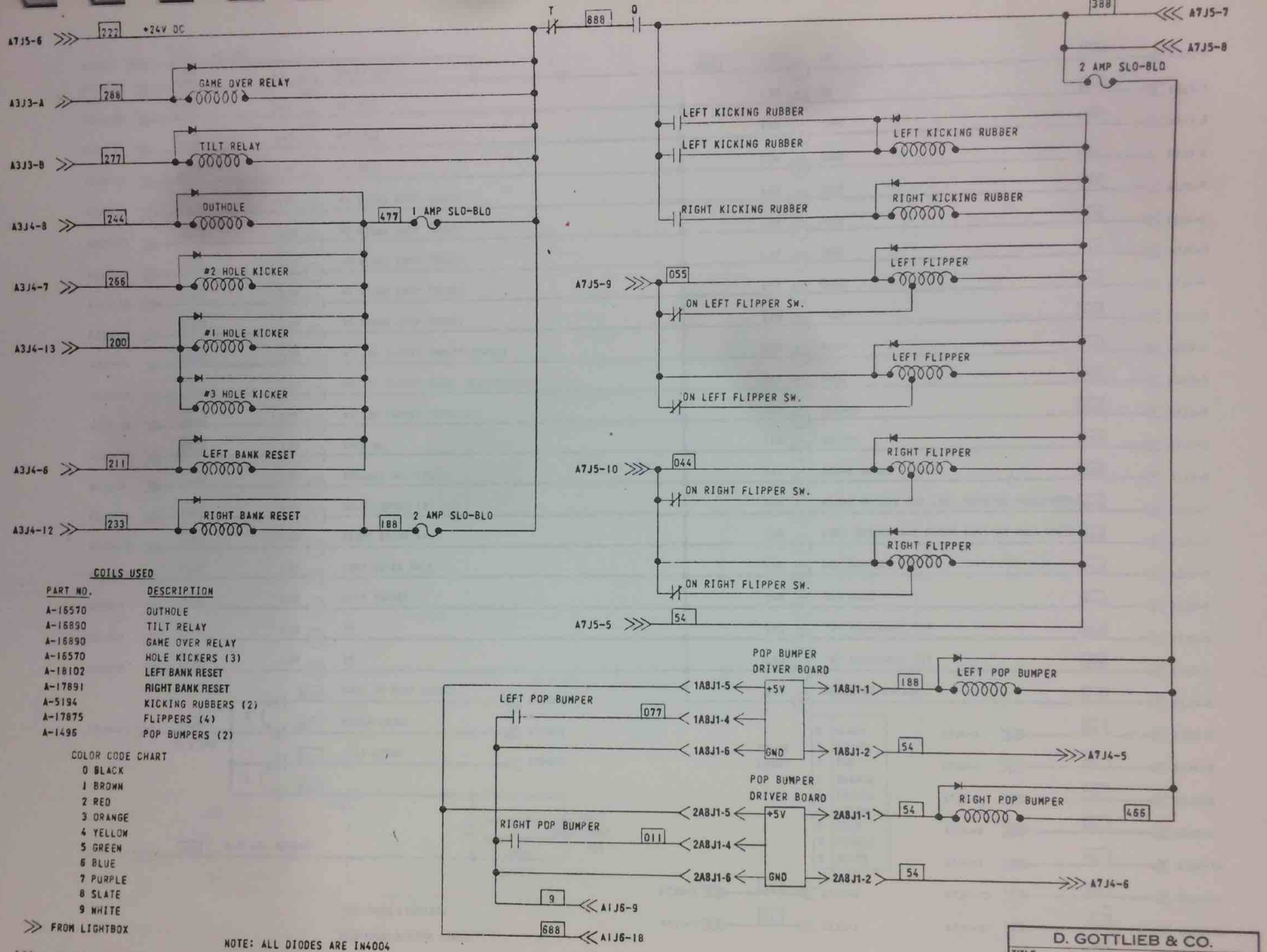
D. GOTTLIEB & CO.			
TITLE: BOTTOM BOARD & LIGHTBOX SCHEMATIC			
USED ON			
DRAWN	APPROVED	DATE	C-19690



COLOR CHART	
0 BLACK	5 GREEN
1 BROWN	6 BLUE
2 RED	7 PURPLE
3 ORANGE	8 SLATE
4 YELLOW	9 WHITE

NOTE:
DIODES ARE IN-270

D. GOTTLIEB & CO.			
TITLE SWITCH MATRIX			
USED ON			
DRAWN	APPROVED	DATE	C-19823



COILS USED

PART NO.	DESCRIPTION
A-16570	OUTHOLE
A-16890	TILT RELAY
A-16890	GAME OVER RELAY
A-16570	HOLE KICKERS (3)
A-18102	LEFT BANK RESET
A-17891	RIGHT BANK RESET
A-5194	KICKING RUBBERS (2)
A-17875	FLIPPERS (4)
A-1495	POP BUMPERS (2)

COLOR CODE CHART

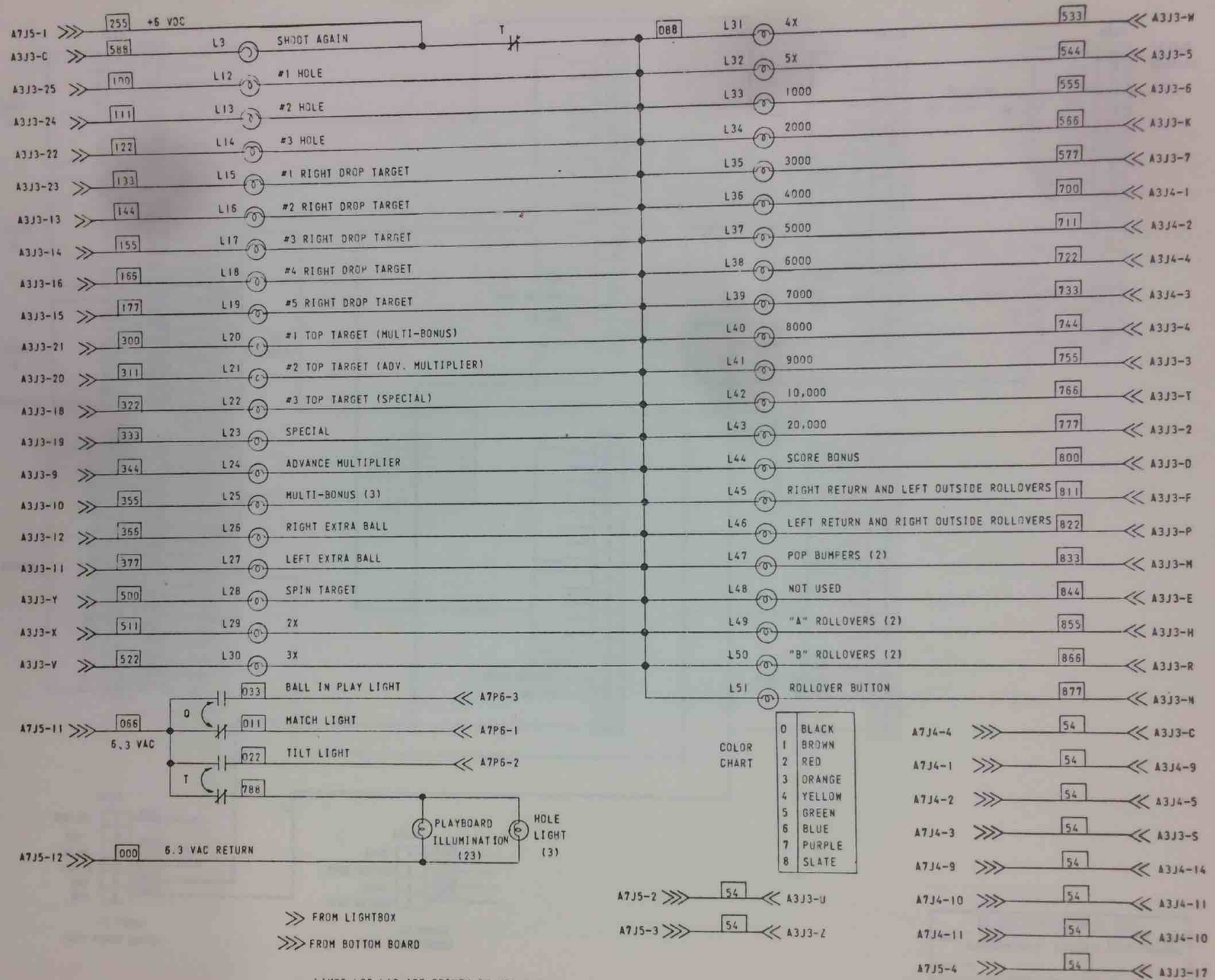
0 BLACK
1 BROWN
2 RED
3 ORANGE
4 YELLOW
5 GREEN
6 BLUE
7 PURPLE
8 SLATE
9 WHITE

» FROM LIGHTBOX

»» FROM BOTTOM BOARD

NOTE: ALL DIODES ARE IN4004

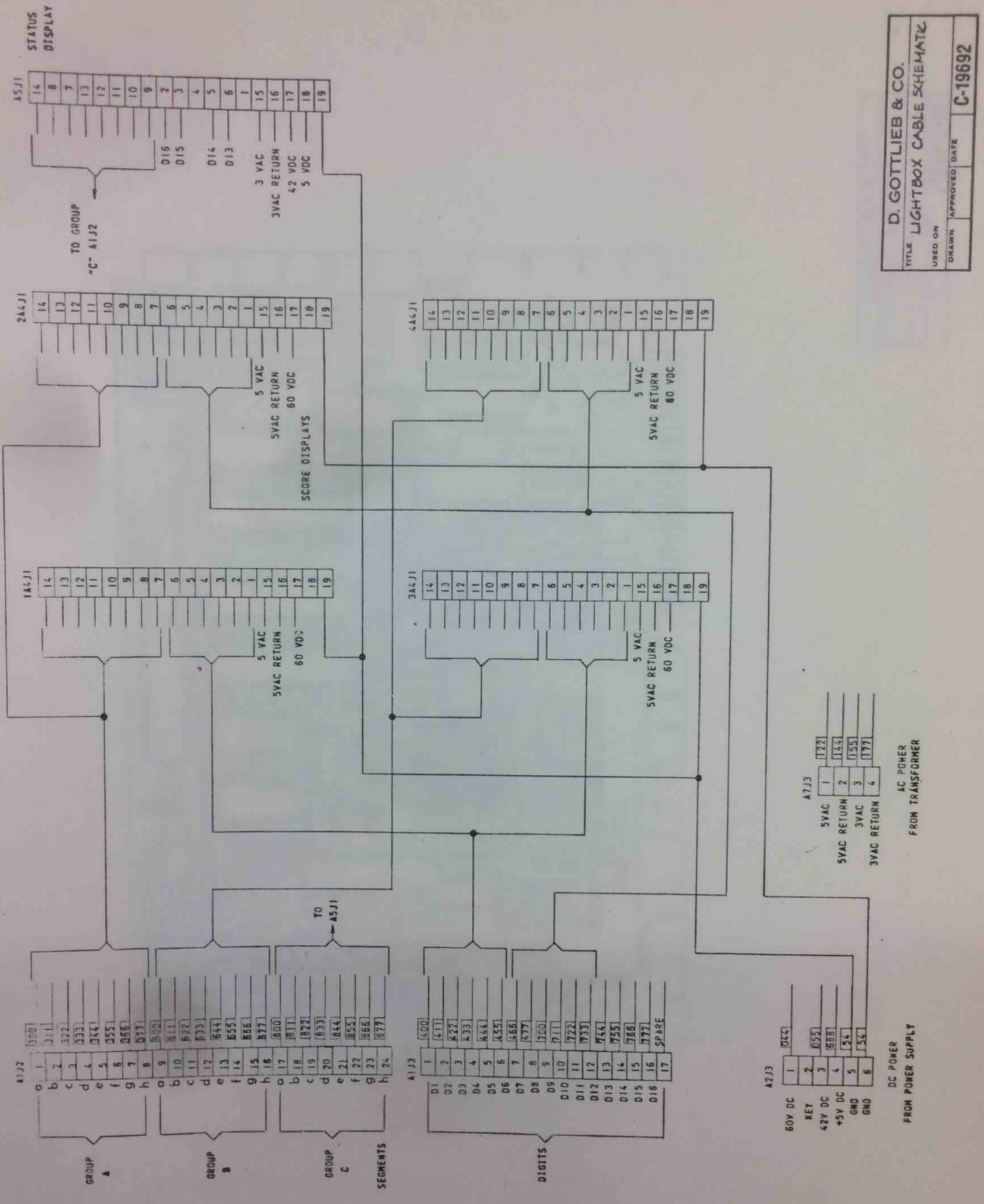
D. GOTTLIEB & CO.			
TITLE PLAYBOARD SOLENOIDS			
USED ON			
DRAWN	APPROVED	DATE	C-19824



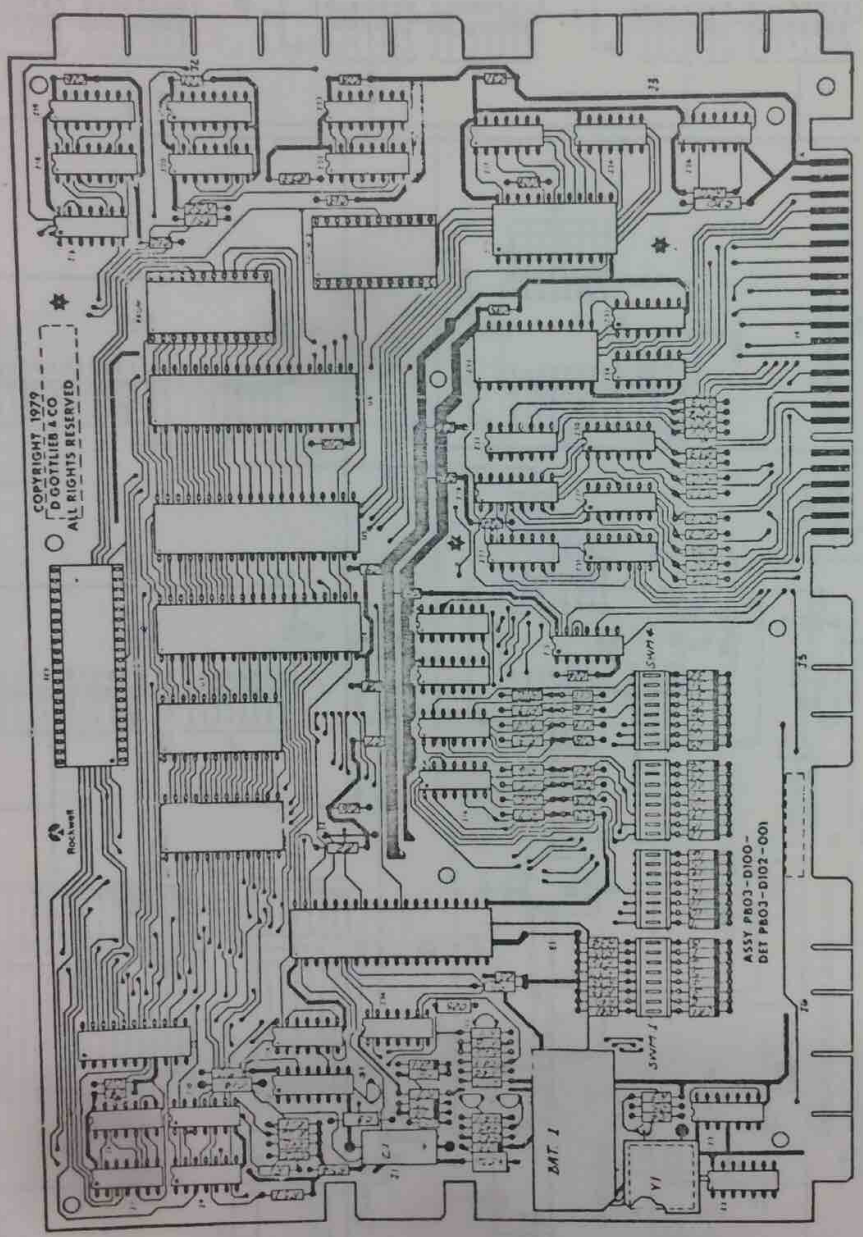
LAMPS L32-L43 ARE DRIVEN BY MPS.A13'S.
ALL OTHER LAMP DRIVERS ARE MPS U45'S.

D. GOTTLIEB & CO.			
TITLE: PLAYBOARD ILLUMINATION			
USED ON:			
DRAWN	APPROVED	DATE	C-19825

G. LIGHTBOX CABLE SCHEMATIC

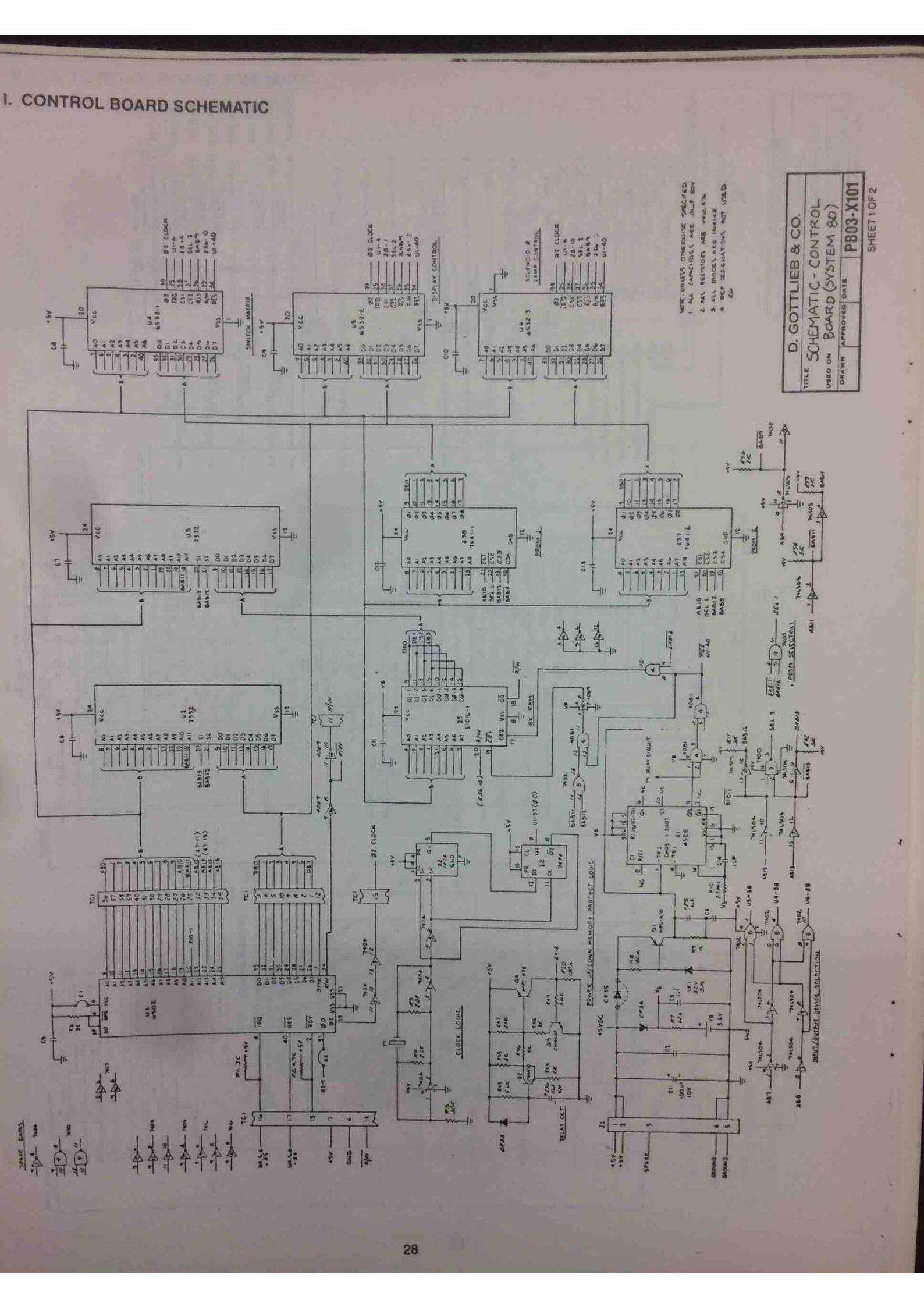


X. H. CONTROL BOARD COMPONENT LOCATION

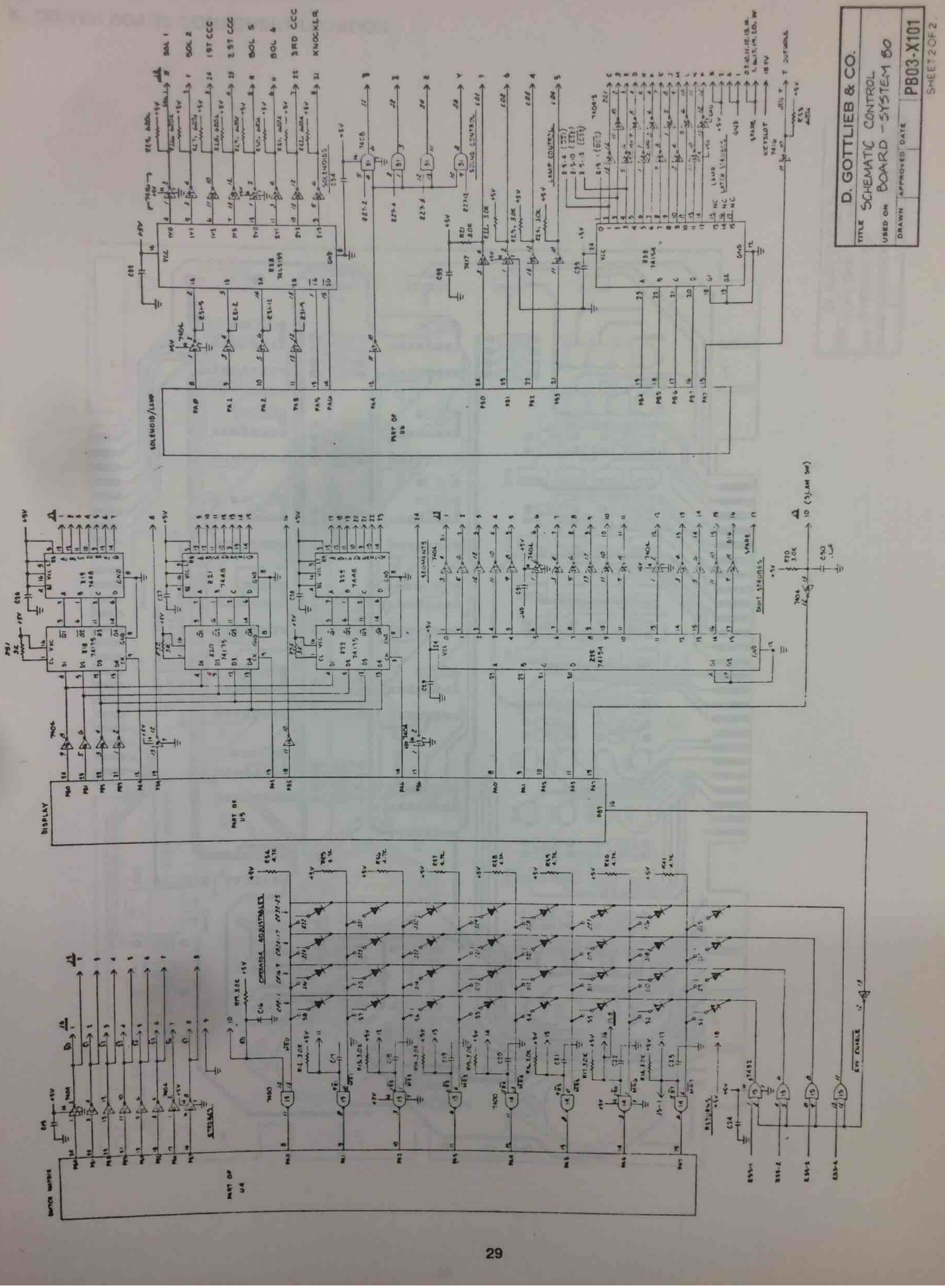


D. GOTTLIEB & CO.			
TITLE CONTROL BOARD			
USED ON SYSTEM 80			
DRAWN	APPROVED	DATE	PB03-D100

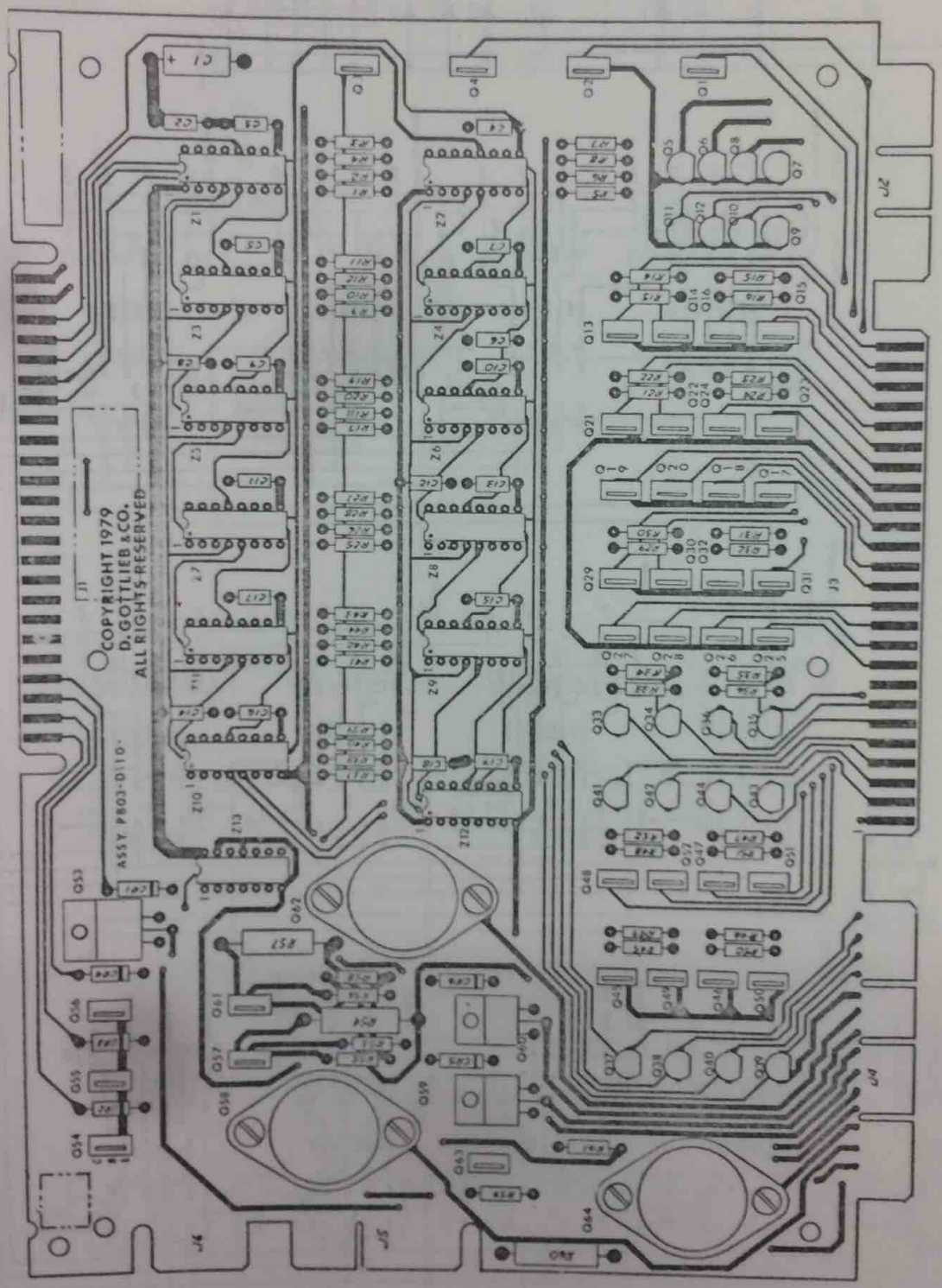
I. CONTROL BOARD SCHEMATIC



X. J. CONTROL BOARD SCHEMATIC

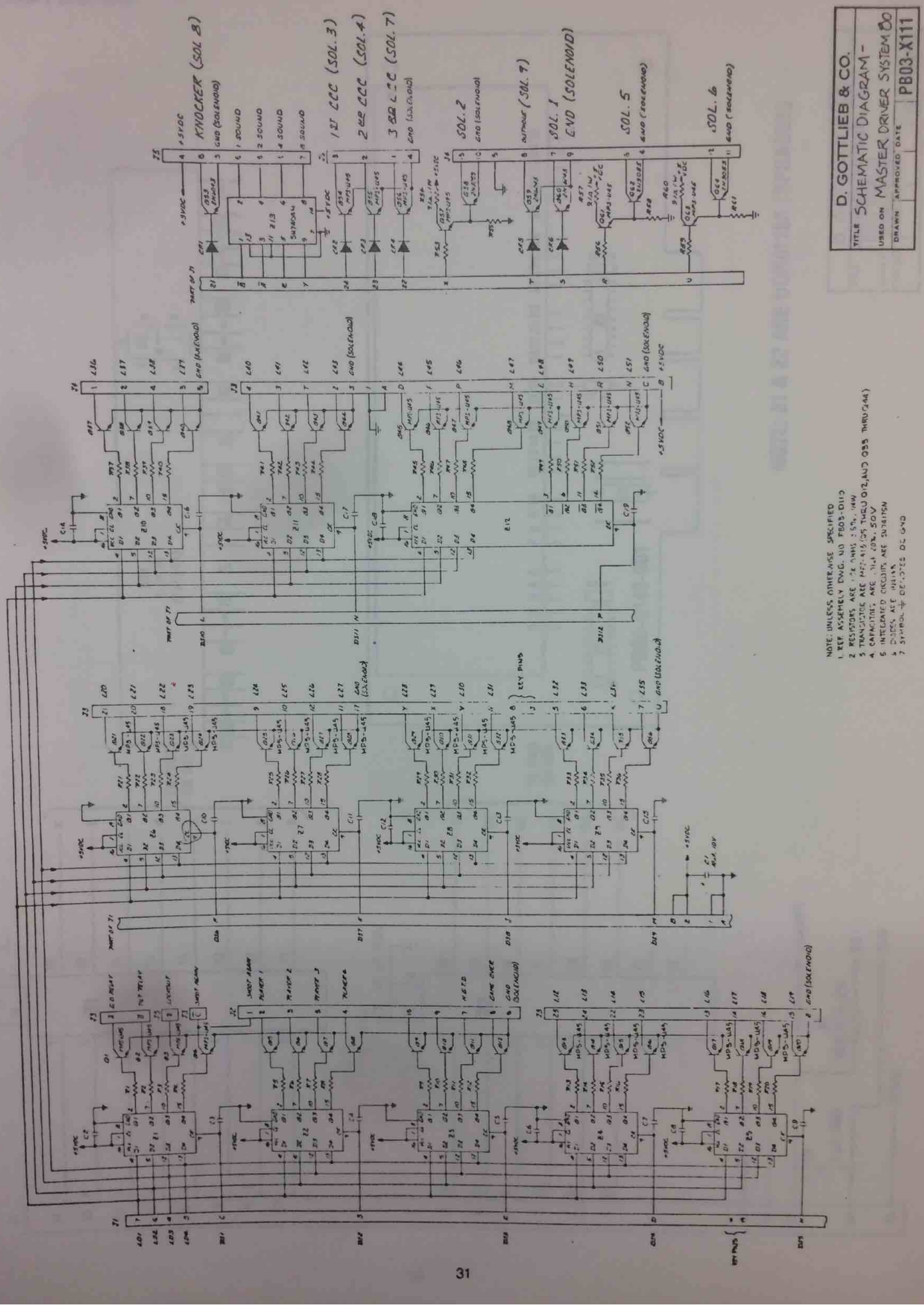


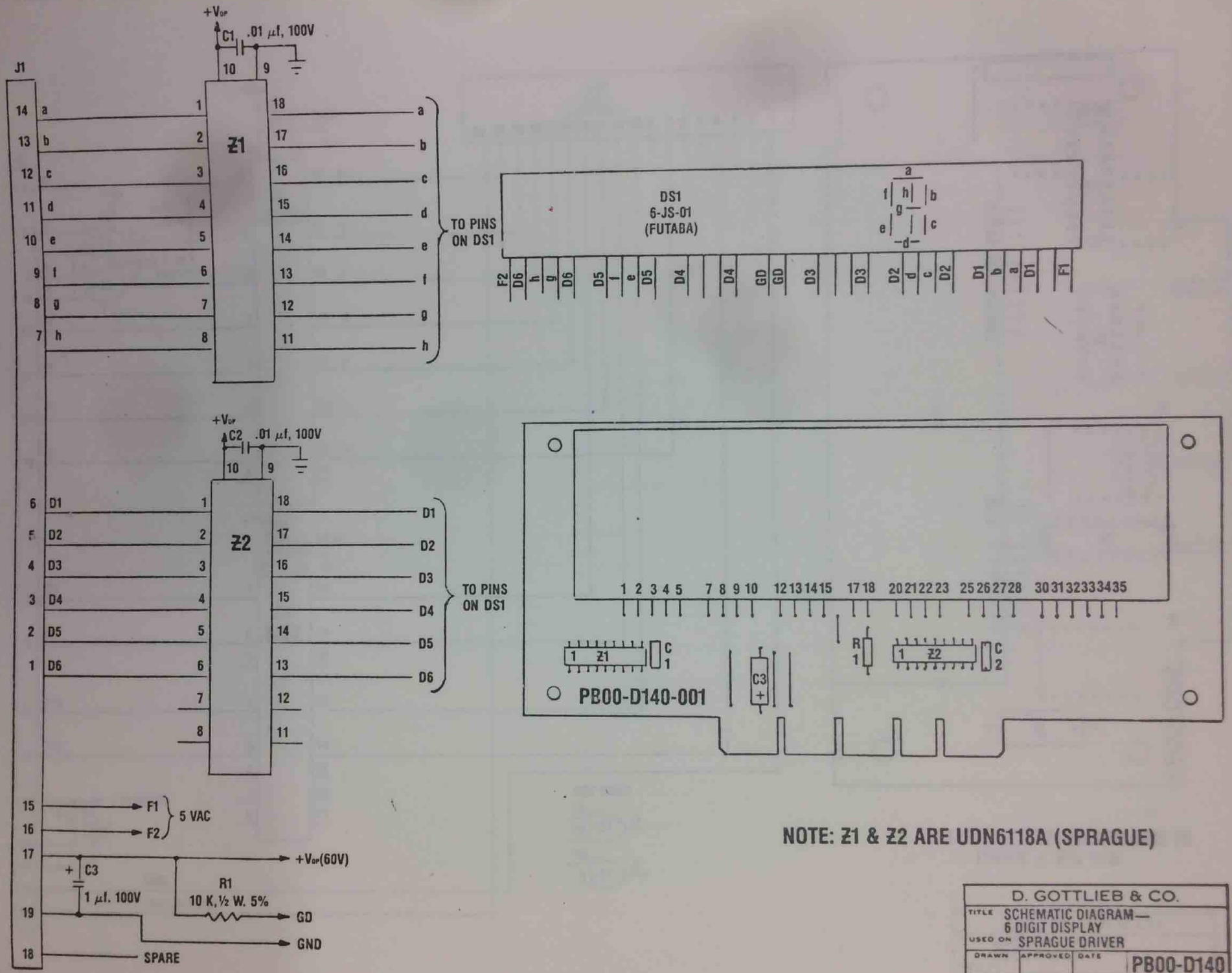
K. DRIVER BOARD COMPONENT LOCATION



D. GOTTLIEB & CO.			
TITLE MASTER DRIVER			
USED SYSTEM 80			
DRAWN	APPROVED	DATE	PB03-D110

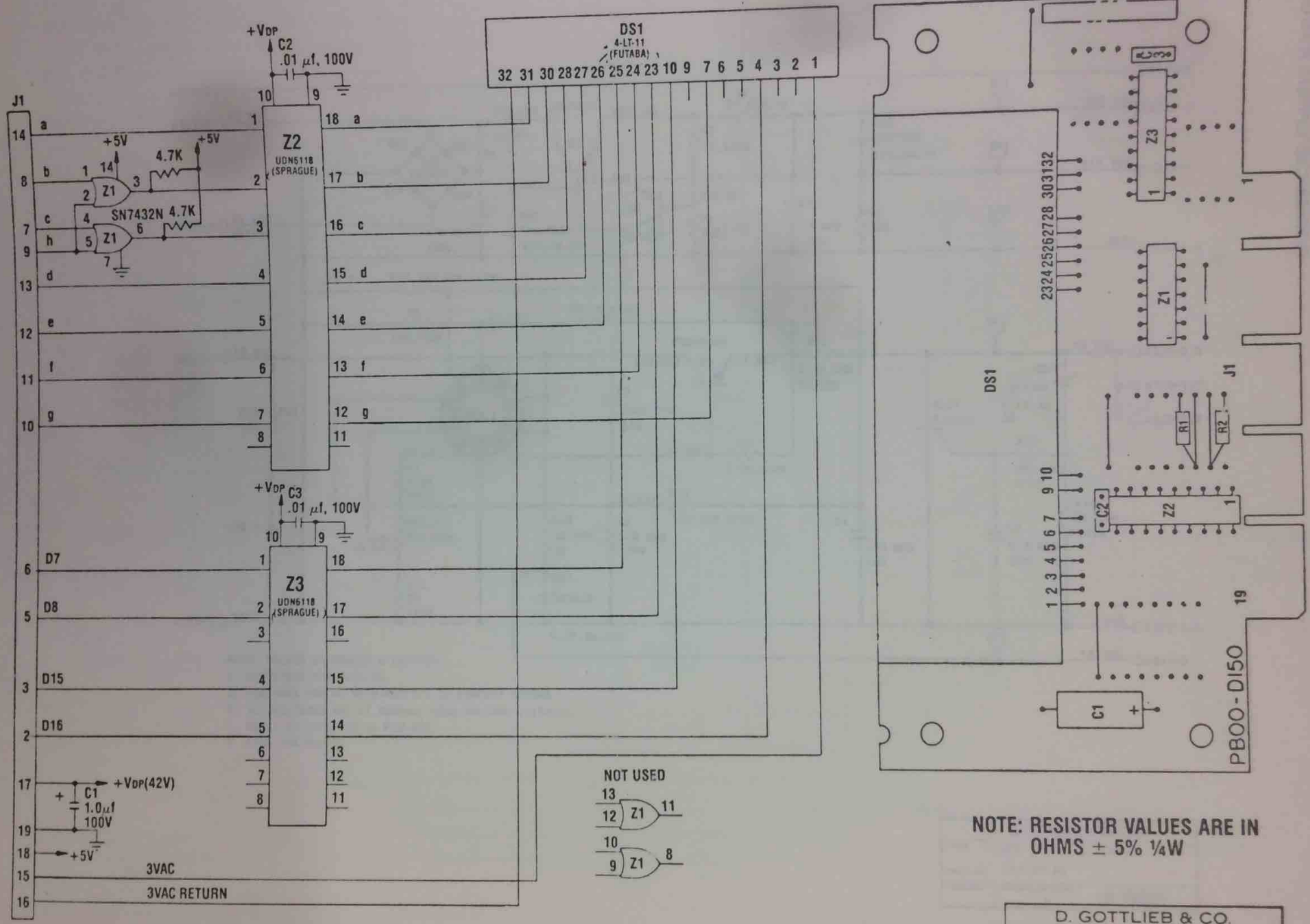
X. L. DRIVER BOARD SCHEMATIC





NOTE: Z1 & Z2 ARE UDN6118A (SPRAGUE)

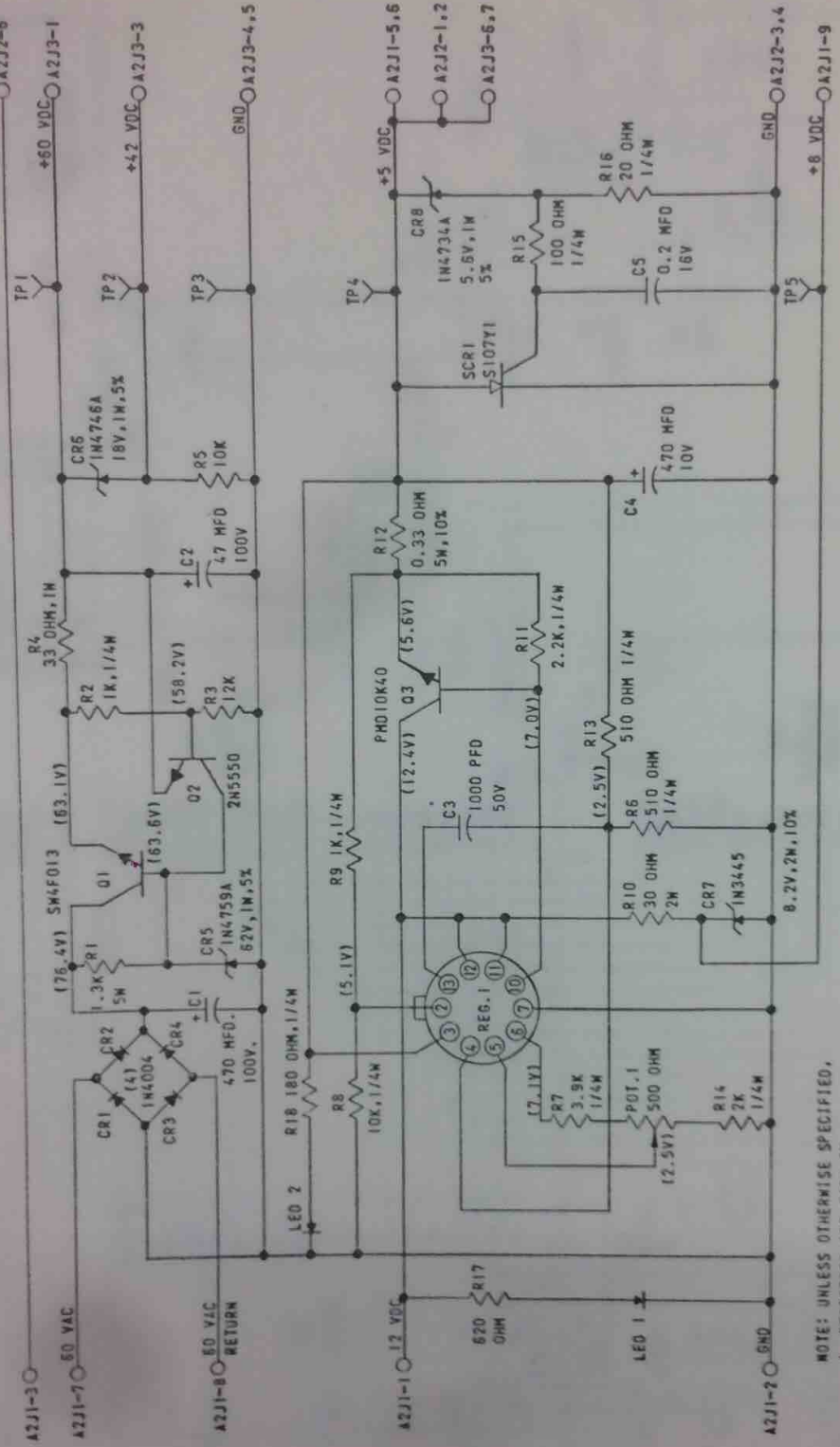
D. GOTTLIEB & CO.			
TITLE SCHEMATIC DIAGRAM— 6 DIGIT DISPLAY			
USED ON SPRAGUE DRIVER			
DRAWN	APPROVED	DATE	PB00-D140



NOTE: RESISTOR VALUES ARE IN OHMS ± 5% ¼W

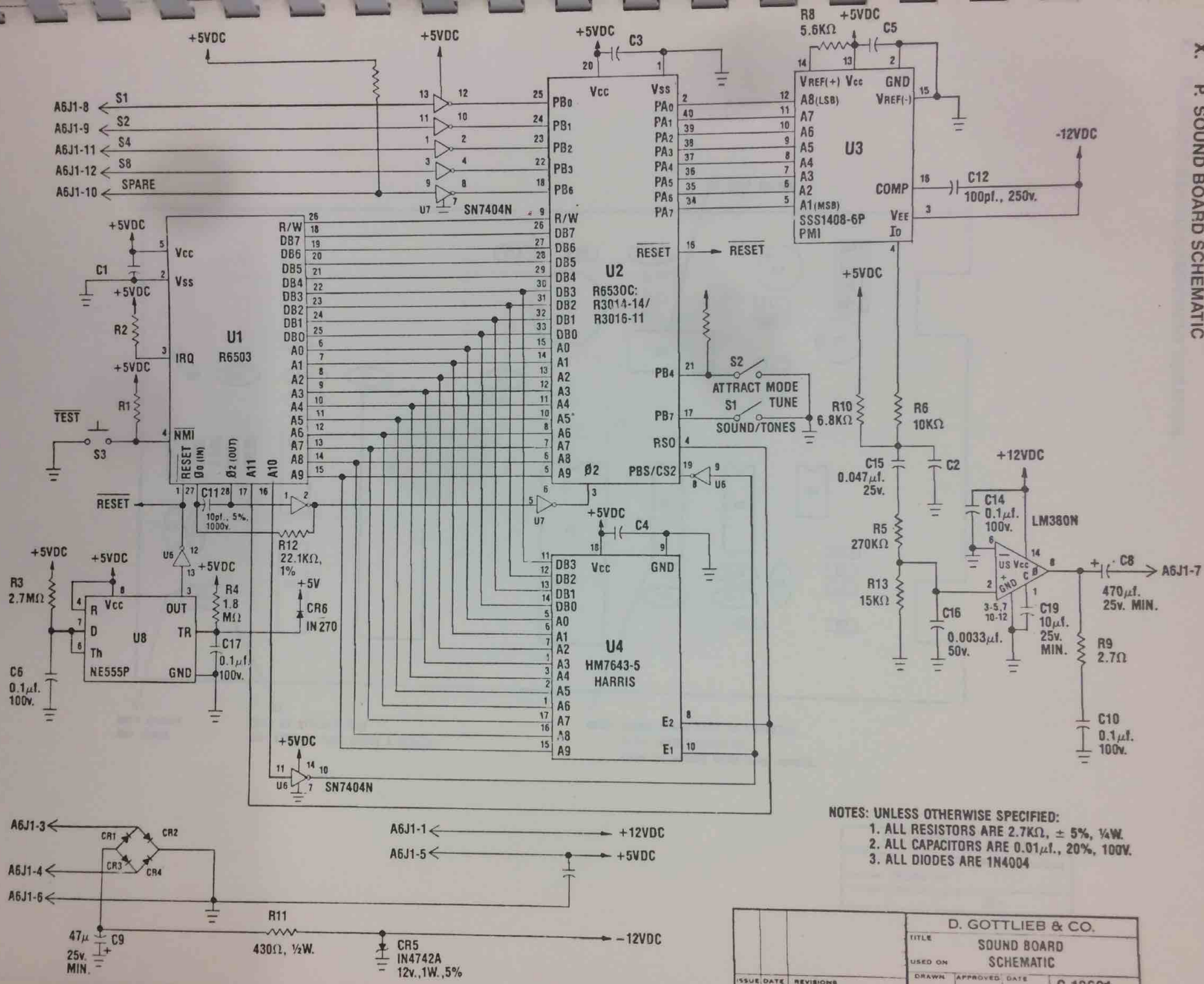
D. GOTTLIEB & CO.			
TITLE SCHEMATIC DIAGRAM- 4 DIGIT DISPLAY			
USED ON			
DRAWN	APPROVED	DATE	PB00-D150

O. POWER SUPPLY SCHEMATIC



NOTE: UNLESS OTHERWISE SPECIFIED,
1. RESISTORS ARE 1/2W,5%
2. VOLTAGES ARE DC WITH RESPECT TO CIRCUIT GROUND
3. ALL VOLTAGES ARE AT NOMINAL LINE VOLTAGE (115VAC)
4. REG.1 IS TYPE 723 14 PIN DIP
5. LEDS ARE RL4050

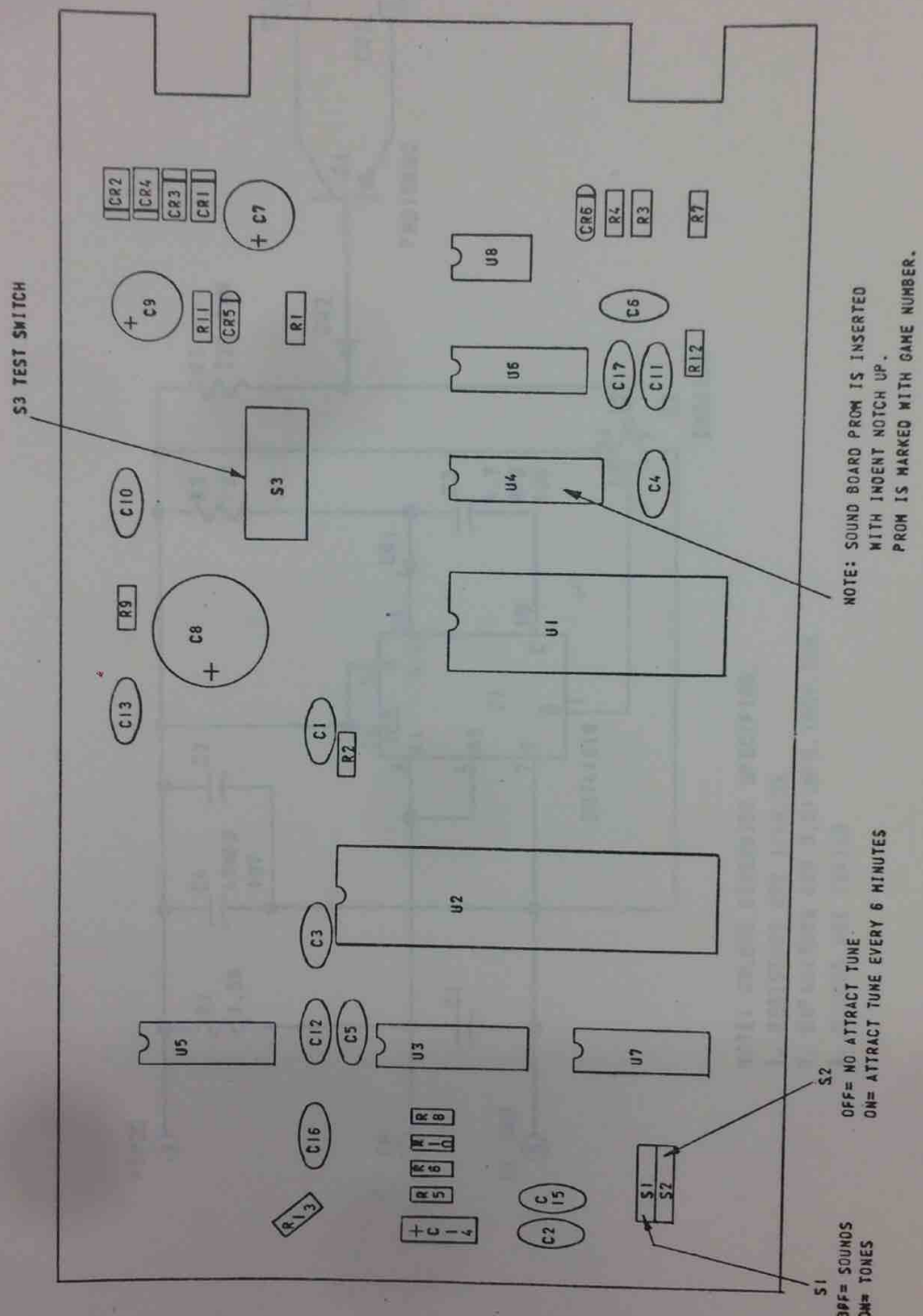
D. GOTTLIEB & CO.			
TITLE	POWER SUPPLY SCHEMATIC		
USED ON	SYSTEM 80		
DRAWN	APPROVED	DATE	B-19694



NOTES: UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ARE 2.7KΩ, ± 5%, ¼W.
2. ALL CAPACITORS ARE 0.01µf., 20%, 100V.
3. ALL DIODES ARE 1N4004

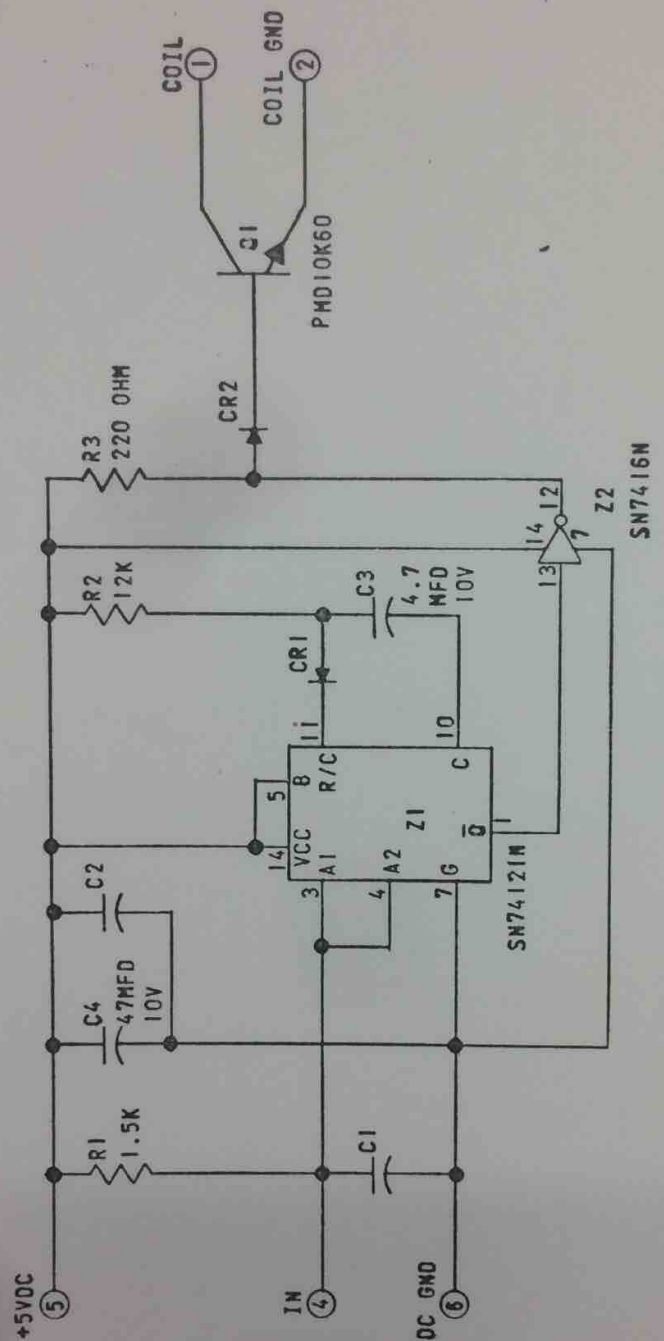
ISSUE	DATE	REVISIONS	D. GOTTLIEB & CO.
			TITLE: SOUND BOARD SCHEMATIC
			USED ON
			DRAWN / APPROVED / DATE: C-19691

X. Q. SOUND BOARD COMPONENT LOCATION



D. GOTTLIEB & CO.		
TITLE SOUND BOARD COMPONENT LOCATION		
USED ON SYSTEM 80		
DRAWN	APPROVED	DATE
		B-

X. R. POP BUMPER DRIVER BOARD SCHEMATIC



NOTE: UNLESS OTHERWISE SPECIFIED.
1. RESISTORS ARE 1/4W,5%
2. CAPACITORS ARE 0.01,MFD.100V,20%
3. DIODES ARE IN4148

D. GOTTLIEB & CO.			
TITLE	POP BUMPER DRIVER BOARD		
USED ON	SYSTEM 80		
DRAWN	APPROVED	DATE	A-19602